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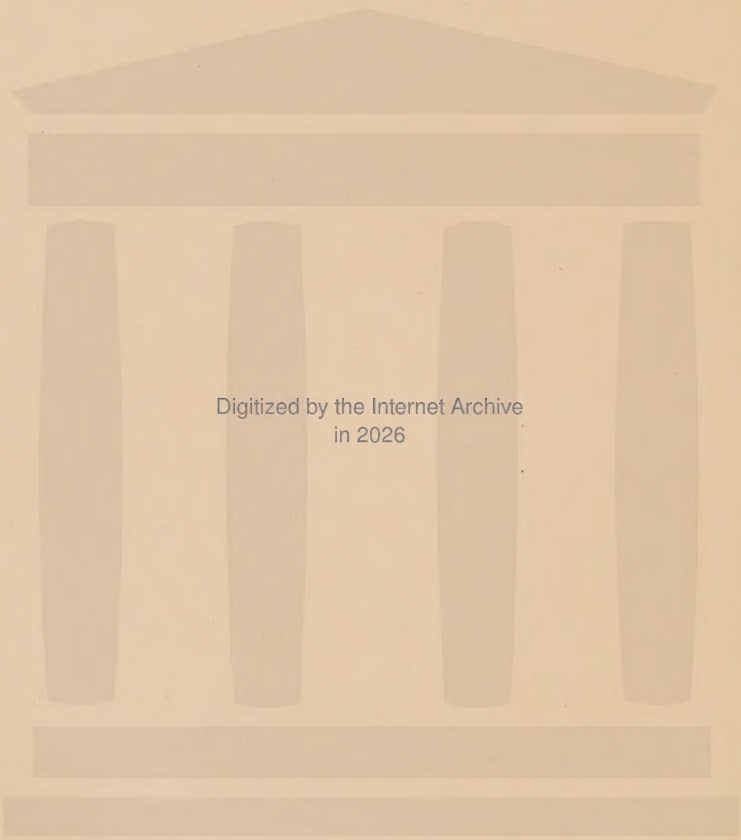
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TRANSACTIONS

OF THE

AMERICAN

SURGICAL ASSOCIATION.

VOLUME THE TWENTY-FOURTH

EDITED BY

RICHARD H. HARTE, M.D.,
RECORDER OF THE ASSOCIATION.

PRINTED FOR THE ASSOCIATION

FOR SALE BY

WILLIAM J. DORNAN, PHILADELPHIA.

1906.

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OFFICERS OF THE ASSOCIATION,

ELECTED JUNE, 1906.

PRESIDENT.

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VICE-PRESIDENTS.

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A. F. JONAS, M.D.

SECRETARY.

ROBERT G. LE CONTE, M.D.,
1530 Locust St., Philadelphia.

TREASURER.

CHAS. A. POWERS, M.D.,
Fourteenth and Stout Sts., Denver, Colo.

RECORDER.

RICHARD H. HARTE, M.D.,
1503 Spruce Street, Philadelphia.

COUNCIL.

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} *Ex-officio.*

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PRESIDENT, SECRETARY, RECORDER AND THE CHAIRMAN OF THE COMMITTEE OF ARRANGEMENTS,
ex-officio.

COMMITTEE ON NECROLOGY, CREATED IN 1884.
(Report by Title.)

F. H. GERRISH, M.D.,
N. B. CARSON, M.D.,
WM. L. RODMAN, M.D.

Place of next meeting:

WASHINGTON, D. C., MAY 7, 8, AND 9, 1907.

COMMITTEE OF ARRANGEMENTS.

GEO. TULLY VAUGHAN, M.D., *Chairman,*
J. M. T. FINNEY, M.D.,
LEWIS C. BOSHER, M.D.

CONGRESS OF AMERICAN PHYSICIANS AND SURGEONS,
WASHINGTON, 1907.

Delegate: W. W. KEEN, M.D.
Alternate: A. J. McCOSH, M.D.

LIST OF THE PRESIDENTS

OF THE

ASSOCIATION FROM THE TIME OF ITS INSTITUTION.

ELECTED

1880. †SAMUEL DAVID GROSS, M.D., LL.D., D.C.L. Oxon., LL.D. Cantab., LL.D. Edin.—Founder of the Association.
1883. †EDWARD MOTT MOORE, M.D., LL.D.
1884. †WILLIAM THOMPSON BRIGGS, M.D
1885. †MOSES GUNN, A.M., M.D., LL.D.
1886. †HUNTER McGUIRE, M.D., LL.D.
1887. †D. HAYES AGNEW, M.D., LL.D.
1888. DAVID WILLIAMS CHEEVER, M.D., LL.D.
1889. †DAVID W. YANDELL, M.D.
1890. †CLAUDIUS HENRY MASTIN, M.D., LL.D.
1891. PHINEAS SANBORN CONNER, M.D., LL.D.
1892. NICHOLAS SENN, M.D., Ph.D., LL.D.
1893. J. EWING MEARS, A.M., M.D.
1894. FREDERIC SHEPARD DENNIS, M.D.
1895. LOUIS McLANE TIFFANY, A.M. Cantab., M.D.
1896. JOHN COLLINS WARREN, M.D., LL.D. (Jefferson), Hon. F.R.C.S. Eng.
1897. †THEODORE F. PREWITT, M.D.
1898. WILLIAM W. KEEN, A.M., M.D., LL.D., Hon. F.R.C.S. Eng.
1899. ROBERT F. WEIR, A.M., M.D., F.R.C.S. Eng.
1900. ROSWELL PARK, M.D.
1901. DE FOREST WILLARD, A.M., M.D., Ph.D.
1902. MAURICE H. RICHARDSON, A.B., M.D.
1903. NATHANIEL P. DANDRIDGE, M.D.
1904. GEORGE BEN JOHNSTON, M.D.
1905. ALBERT VANDER VEER, M.D.
1906. DUDLEY P. ALLEN, M.D.

† Deceased.

NOTICE.

THIS volume of TRANSACTIONS contains the papers read before the Association at the Meeting held May 30, 31, and June 1, 1906.

The Association assumes no responsibility for the statements and opinions published in this volume.

FELLOWS

OF THE

AMERICAN SURGICAL ASSOCIATION.

MAY, 1906.

* Denotes Original Fellows.

ELECTED

1890. Abbe, Robert, M.D., 13 West Fiftieth Street, New York, Surgeon to St. Luke's Hospital. *Vice-President*, 1901.

1894. Allen, Dudley P., A.M., M.D., *Secretary*, 1110 (old 260) Euclid Ave., Cleveland, Ohio. Professor of Surgery, Medical Department of Western Reserve University; Visiting Surgeon, Lakeside and Charity Hospitals; Consulting Surgeon to the Cleveland City Hospital.

1890. Allis, Oscar Huntington, A.M., M.D., 1604 Spruce Street, Philadelphia. Surgeon to the Presbyterian Hospital.

1902. Andrews, E. Wyllys, A.M., M.D., 2525 Prairie Avenue, Chicago, Ill. Professor of Surgery, Northwestern University Medical School; Surgeon to Mercy Hospital and Michael Reese Hospital; Attending Surgeon to Cook County Hospital; Consulting Surgeon to the Provident Hospital.

1901. Armstrong, George E., C.M., M.D., 320 Mountain Street, Montreal. Associate Professor of Clinical Surgery, McGill University; Surgeon to the Montreal General Hospital; Surgeon to the Western Hospital, Montreal.

1906. Barrow, David, M.D., 148 Market Street, Lexington, Ky.

1882. Barton, James M., A.M., M.D., 1337 Spruce Street, Philadelphia. Surgeon to the Jefferson Medical College Hospital and to the Philadelphia Hospital.

ELECTED

1901. Bell, James, M.D., *Vice-President*, 873 Dorchester Street, Montreal. Professor of Clinical Surgery, McGill University; Surgeon to the Royal Victoria Hospital.

1900. Bevan, Arthur Dean, M.D., 100 State Street, Chicago. Associate Professor of Surgery, Rush Medical College, University of Chicago; Surgeon to Presbyterian Hospital.

1901. Binnie, J. F., M.B., C.M. (Aberdeen), Argyle Bldg., Twelfth and McGee Sts. Kansas City, Mo. Professor of Surgical Pathology and Clinical Surgery, Kansas City Medical College.

1906. Blake, John Bapst, A.M., M.D., 178 Beacon Street, Boston, Mass. Instructor in Surgery, Harvard Medical School; Assistant Surgeon to the Boston City Hospital; Surgeon to the Long Island Hospital and St. Elizabeth's Hospital, Boston, Mass.

1902. Blake, Joseph A., M.D., 601 Madison Avenue, New York. Instructor in Surgery, Columbia University; Attending Surgeon to St. Luke's Hospital; Junior Surgeon to the Roosevelt Hospital; Consulting Surgeon to the Northern Dispensary.

1901. Bloodgood, Joseph C., B.S., M.D., 923 North Charles Street, Baltimore, Md. Associate in Surgery in the Johns Hopkins University.

1882. Bontecou, Reed Brockway, M.D., 82 Fourth Street, Troy, N. Y. Surgeon to the Marshall Infirmary.

1901. Bosher, Lewis C., M.D., 717 East Franklin Street, Richmond, Va. Professor of Surgery, Medical College of Virginia; Surgeon to the Old Dominion Hospital.

1890. Bradford, Edward Hickling, A.B., M.D., 133 Newbury Street, Boston. Surgeon to the Children's and the Samaritan Hospitals; Assistant Professor of Orthopedic Surgery in the Harvard University.

1900. Brewer, George Emerson, M.D., 61 West Forty-eight Street, New York City. Professor of Clinical Surgery in College of Physicians and Surgeons, Columbia University; Junior Surgeon, Roosevelt Hospital; Attending Surgeon, City Hospital; Consulting Surgeon to the Ophthalmic and Aural Institute, and to the Perth Amboy Hospital.

*1880. Brinton, John H., M.D., 1423 Spruce Street, Philadelphia. Professor of the Practice of Surgery and of Clinical Surgery in the Jefferson Medical College; Surgeon to St. Joseph's Hospital. *Treasurer*, 1884–85.

1906. Bristow, A. T., A.B., M.D., 234 Clinton Street, Brooklyn, New York. Clinical Professor of Surgery at the Long Island College Hospital; Attending Surgeon to the Kings County Hospital,

ELECTED

St. John's Hospital, and Long Island College Hospital; Consulting Surgeon to the Long Island State Hospital, the Bushwick Central Hospital and the Swedish Hospital.

1895. BRYANT, JOSEPH D., M.D., 32 West Forty-eighth Street, New York. Professor of Anatomy and of Operative and Clinical Surgery, Bellevue and St. Vincent's Hospitals; Consulting Surgeon to Gouverneur Hospital, Hospital for Ruptured and Crippled, St. Joseph's and Hackensack Hospitals, Asylum for Insane, New York, etc.

1882. BULL, WILLIAM TILLINGHAST, A.B., M.D., 35 West Thirty-fifth Street, New York. Adjunct Professor of the Practice of Surgery and of Clinical Surgery in the College of Physicians and Surgeons, New York; Surgeon to the New York and St. Luke's Hospitals; Consulting Surgeon to the Hospital for Ruptured and Crippled, and to the New York Cancer Hospital.

1900. BUNTS, FRANK E., M.D., 275 Prospect Street, Cleveland, Ohio. Professor of Principles of Surgery and Clinical Surgery in Medical College of Western Reserve University; Visiting Surgeon to St. Vincent's Charity Hospital; Consulting Surgeon to Cleveland City and Lutheran Hospitals.

1893. BURRELL, HERBERT LESLIE, M.D. (Harvard), 22 Newbury Street, Boston, Mass. Assistant Professor of Surgery in Harvard University; Visiting Surgeon, Boston City Hospital; Visiting Surgeon to the Children's Hospital; Consulting Surgeon, Carney Hospital and the Quincy Hospital. *Secretary* 1895–1901.

1889. CABOT, ARTHUR TRACY, A.M., M.D., 1 Marlborough Street, Boston, Mass. Surgeon to Massachusetts General Hospital.

1885. CARMALT, WILLIAM H., A.M., M.D., 87 Elm Street, New Haven, Conn. Professor of Surgery in Yale University; Surgeon to the New Haven Hospital. *Vice-President*, 1895.

1896. CARSON, NORMAN BRUCE, M.D., 303 Humboldt Bldg., St. Louis, Mo. Professor of Clinical Surgery in the St. Louis Medical College; Surgeon to St. Louis and Mullanphy Hospitals and to the St. Vincent Insane Asylum, etc. *Vice-President*, 1903.

1882. CHEEVER, DAVID WILLIAMS, M.D., LL.D., 557 Boylston Street, Boston, Mass. Professor of Surgery (Emeritus) in Harvard University; Surgeon to Boston City Hospital. *President*, 1888.

1896. COLE, CHARLES KNOX, A.M., M.D., Helena, Montana. Surgeon to St. John's, St. Peter's and County Hospitals.

ELECTED

1898. Coley, William B., M.D., 5 Park Avenue, New York. Attending Surgeon to the General Memorial Hospital; Associate Surgeon to the Hospital for Ruptured and Crippled, New York.

*1880. Conner, Phineas Sanborn, M.D., LL.D., 215 West Ninth Street, Cincinnati, Ohio. Professor of Surgery in the Medical College of Ohio; Emeritus Professor of Surgery, Dartmouth Medical College; Surgeon to the Cincinnati and the Good Samaritan Hospitals. *President*, 1891; *Member of Council*, 1883 and 1895–1900; *Treasurer*, 1885–91.

1905. Crile, George W., M.D., 275 Prospect St., Cleveland, Ohio. Professor of Clinical Surgery, Western Reserve Medical College; Visiting Surgeon to St. Alexis' Hospital; Associate Surgeon to Lakeside Hospital.

1896. Curtis, Benjamin Farquhar, A.B., M.D., 7 East Forty-first Street, New York. Professor of the Principles of Surgery and Clinical Surgery, University and Bellevue Hospital Medical College of New York; Attending Surgeon to St. Luke's and Bellevue Hospitals, and the General Memorial Hospital for Treatment of Cancer and Allied Diseases; Consulting Surgeon to New York Orthopedic Hospital and Dispensary.

1906. Cushing, Harvey, A.M., M.D., 3 West Franklin Street, Baltimore, Md. Associate Professor of Surgery, Johns Hopkins University.

1896. Cushing, Hayward Warren, A.B., M.D., 70 Commonwealth Avenue, Boston, Mass. Junior Visiting Surgeon, Boston City Hospital; Assistant Surgeon, Children's Hospital, Boston.

1897. Da Costa, John Chalmers, M.D., 2045 Walnut Street, Philadelphia, Pa. Clinical Professor of Surgery, Jefferson Medical College; Surgeon to the Philadelphia and the Phœnixville Hospitals.

1883. Dandridge, Nathaniel Pendleton, M.D., 422 Broadway, Cincinnati, Ohio. Professor of Practice of Surgery and of Clinical Surgery in the Miami Medical College, Cincinnati. *President*, 1904. *Treasurer*, 1894–96. *Member of Council*, 1904.

1892. Deaver, John B., M.D., 1634 Walnut Street, Philadelphia. Surgeon-in-Chief to the German Hospital, Philadelphia.

1882. Dennis, Frederic Shepard, M.D., F.R.C.S. Eng., 542 Madison Avenue, New York. Professor of Clinical Surgery, Cornell University, New York City; Visiting Surgeon to the Bellevue and St. Vincent's Hospitals; Consulting Surgeon to St. Joseph's Hospital, Yonkers, and Montefiore Home, New

ELECTED

York City. *President*, 1894; *Vice-President*, 1887; *Member of Council*, 1889.

1901. ELIOT, ELLSWORTH, JR., M,D., 48 West Thirty-sixth Street, New York. Clinical Lecturer and Demonstrator of Surgery, College of Physicians and Surgeons, New York; Surgeon to the Presbyterian Hospital.

1893. ELLIOT, JOHN WHEELOCK, A.M., M.D. (Harvard), 124 Beacon Street, Boston. Surgeon to Massachusetts General Hospital.

1896. ESTES, WILLIAM LAWRENCE, A.M., M.D., South Bethlehem, Pa. Director and Surgeon-in-Chief of St. Luke's Hospital; Lecturer on Hygiene at Lehigh University.

1898. EVE, DUNCAN, A.M., M.D., 700 Church Street, Nashville, Tenn. Professor of Surgery and Clinical Surgery, Medical Department, Vanderbilt University; Surgeon to the Nashville City Hospital.

1901. FERGUSON, ALEX. HUGH, C.M., M.D., 10 Drexel Square, Chicago, Ill. Professor of Clinical Surgery in the Medical Department of the University of the State of Illinois; Professor of Surgery in the Post-Graduate Medical School of Chicago; Surgeon-in-Chief of the Chicago Hospital; Surgeon to Cook County Hospital for the Insane; Consulting Surgeon to Provident Hospital.

1899. FINNEY, JOHN M. T., M.D., 1300 Eutaw Place, Baltimore, Md. Associate Professor of Surgery, Johns Hopkins University.

1904. FRAZIER, CHARLES HARRISON, M.D., 1724 Spruce Street, Philadelphia, Pa. Professor of Clinical Surgery, University of Pennsylvania; Surgeon to the University Hospital.

1898. FREEMAN, LEONARD, B.S., M.D., 1801 Franklin Street, Denver, Col. Professor of Surgery, Gross Medical College; Surgeon to the Arapahoe County Hospital and to St. Anthony's Hospital.

1882. GAY, GEORGE WASHINGTON, A.M., M.D., 665 Boylston Street, Boston, Mass. Senior Surgeon to the Boston City Hospital, Clinical Instructor in Surgery in Harvard University. *Member of Council*, 1882.

1892. GERRISH, FREDERIC HENRY, A.M., M.D. (Bowdoin), LL.D. (University of Michigan and Bowdoin), 675 Congress Street, Portland, Maine. Professor of Surgery in the Medical Department of Bowdoin College; Consulting Surgeon, Maine General Hospital.

ELECTED

1890. GERSTER, ARPAD G., M.D., Chir. D., 34 East Seventy-fifth Street, New York. Professor of Surgery in the New York Polyclinic; Surgeon to the German and Mount Sinai Hospitals.

1906. GIBBON, JOHN H., M.D., 1608 Spruce Street, Philadelphia. Associate Professor of Surgery, Jefferson Medical College; Surgeon to the Pennsylvania Hospital and the Bryn Mawr Hospital; Consulting Surgeon to the Woman's Hospital.

1906. GIBSON, C. L., M.D., 8 East Fifty-eighth Street, New York, N. Y. Professor of Clinical Surgery, Cornell University Medical College; Surgeon to St. Luke's and the City Hospitals.

1892. HALSTEAD, WILLIAM STEWART, B.A., M.D., 1201 Eutaw Place, Baltimore, Md. Surgeon to Johns Hopkins Hospital.

1898. HARRINGTON, FRANCIS B., A.B. (Tufts College), M.D. (Harvard College), 201 Beacon Street, Boston, Mass. Surgeon to Massachusetts General Hospital.

1900. HARRIS, MALCOLM L., M.D., 612 Reliance Building, Chicago, Ill. Professor of Surgery, Chicago Polyclinic; Attending Surgeon, Alexian Brothers' Hospital, St. Luke's Hospital, and Maurice Porter Hospital for Children.

1895. HARTE, RICHARD H., M.D., *Recorder*, 1503 Spruce Street, Philadelphia. Associate Professor of Surgery, University of Pennsylvania; Surgeon to the Pennsylvania Hospital, and Orthopædic Hospital and Infirmary for Nervous Diseases; Consulting Surgeon to St. Mary's, St. Timothy's, and Bryn Mawr Hospitals.

1898. HEARN, W. JOSEPH, M.D., 1120 Walnut Street Philadelphia. Clinical Professor of Surgery, Jefferson Medical College; Visiting Surgeon to the Philadelphia Hospital; Consulting Surgeon to the Phœnixville General Hospital.

1899. HORWITZ, ORVILLE, M.D., 1721 Walnut Street, Philadelphia. Clinical Professor of Genito-Urinary Diseases, Jefferson Medical College; Surgeon to the Philadelphia Hospital; Consulting Surgeon to State Hospital for Insane and Hayes Mechanics' Home.

1901. HUNTINGTON, THOMAS W., A.B., M.D., 1118 Sutter Street, San Francisco, California. Professor of Clinical and Operative Surgery, Medical Department, University of California; Visiting Surgeon to the City and County Hospital, San Francisco; Consulting Surgeon, St. Luke's Hospital, San Francisco.

ELECTED

1901. JACOBSON, NATHAN, M.D., 430 South Salina Street, Syracuse, N. Y. Professor of Clinical Surgery, College of Medicine, Syracuse University; Surgeon to St. Joseph's Hospital.

1901. JOHNSON, ALEXANDER B., M.D., 12 East Fifty-eighth Street, New York. Professor of Clinical Surgery, Cornell University Medical College; Attending Surgeon to New York Hospital.

1905. JOHNSON, ROBERT W., A.B., M.D., 101 W. Franklin Street, Baltimore, Md. Professor of Principles and Practice of Surgery, Baltimore Medical College; Surgeon to Maryland General Hospital; Church Home and Infirmary; St. Agnes' Hospital.

1896. JOHNSTON, GEORGE BEN, M.D., 405 East Grace Street, Richmond, Va. Professor of the Practice of Surgery and of Clinical Surgery in the Medical College of Virginia; Surgeon to the Old Dominion Hospital, and Consulting Surgeon to the Richmond City Free Dispensary. *President*, 1904.

1901. JONAS, A. F., M.D., 106 South Thirty-first Avenue, Omaha, Nebraska. Professor of Surgery, Omaha Medical College: Surgeon to the Methodist Episcopal Hospital and to the Douglas County Hospital.

1899. KAMMERER, FREDERICK, M.D., 51 East Sixty-sixth Street, New York City. Professor of Clinical Surgery, Cornell Medical College; Surgeon to the German and St. Francis' Hospitals, New York.

*1880. KEEN, WILLIAM WILLIAMS, A.M., M.D., LL.D., HON. F.R.C.S. ENG., 1729 Chestnut Street, Philadelphia. Professor of the Principles of Surgery and of Clinical Surgery in the Jefferson Medical College; Surgeon to the Jefferson Medical College Hospital; Consulting Surgeon to the Woman's and St. Agnes' Hospitals; Membre Correspondant Etrangé de la Société de Chirurgie de Paris; Membre Honoraire de la Société Belge de Chirurgie. *President*, 1898; *Vice-President*, 1892; *Member of Council*, 1899–1901.

1901. LA GARDE, LOUIS A., M.D., United States Soldiers' Home, Washington, D. C. Professor of Military Surgery, New York University and Bellevue Hospital Medical College; Major and Surgeon United States Army.

1901. LE CONTE, ROBERT G., A.B., M.D., 1530 Locust Street, Philadelphia. Associate Professor of Surgery, University of Pennsylvania; Surgeon to the Pennsylvania, the Children's, and the Bryn Mawr Hospitals.

ELECTED

1903. Lutz, F. J., A.M., M.D., 3337 Lafayette Place, St. Louis, Mo. Professor of Surgery, Medical Department, St. Louis University; Surgeon-in-Chief, Alexian Brothers' Hospital; Surgeon-in-Charge, Josephine Hospital.

1901. McArthur, L. L., M.D., 4415 Drexel Building, Chicago, Ill. Professor of Clinical Surgery, Post-Graduate Medical School; Assistant Professor of Clinical Surgery, Rush Medical College; Surgeon to St. Luke's and Michael Reese Hospitals.

1896. McCosh, Andrew J., B. A., M.D., 16 East Fifty-fourth Street, New York. Surgeon to the Presbyterian Hospital; Clinical Lecturer on Surgery, College of Physicians and Surgeons.

1882. McGraw, Theodore A., M.D., 73 Case Street, Detroit, Michigan. Professor of Surgery in the Detroit Medical College; Surgeon to St. Mary's and Harper Hospitals. *Vice-President*, 1896.

1903. McMurtry, Lewis S., A.M., M.D., 1912 Sixth Street, Louisville, Ky. Professor of Gynecology and Abdominal Surgery, Hospital of Medicine, Louisville, Ky.

1901. Macdonald, Willis G., M.D., 27 Eagle Street, Albany, New York.

1904. MacLaren, Archibald, M.D., B.S., 350 St. Peter Street, St. Paul, Minn. Professor of Clinical Surgery, University of Minnesota.

1906. MacMonagle, Beverly, M.D., 1316 Sutter Street, San Francisco, Cal. Surgeon to the Children's Hospital; Consulting Surgeon to the German Hospital.

1899. Markoe, Francis H., M.D., 15 East Forty-ninth Street, New York. Professor of Clinical Surgery, Medical Department, Columbia University, New York City; Attending Surgeon, St. Luke's and New York Hospitals; Consulting Surgeon, Orthopedic Hospital.

*1889. Marks, Solon, M.D., 136 Wisconsin Street, Milwaukee, Wis. Surgeon to St. Mary's Hospital. *Vice-President*, 1898.

1898. Martin, Edward, M.D., 1506 Locust Street, Philadelphia. Clinical Professor of Surgery, University of Pennsylvania; Clinical Professor of Surgery, Woman's Medical College, Philadelphia; Surgeon to Philadelphia, St. Agnes', and Howard Hospitals.

1895. Mastin, William McDowell, M.D., Northeast corner of Joachim and Conti Streets, Mobile, Ala. Surgeon to the Mobile City Hospital.

ELECTED

1895. MATAS, RUDOLPH, M.D., 2255 St. Charles Avenue, New Orleans, La. Professor of Surgery, Medical Department, Tulane University; Professor of Clinical Surgery, New Orleans Polyclinic; Surgeon to Charity Hospital; Consulting Surgeon to the Eye, Ear, Nose, and Throat Hospital. *Vice-President*, 1901.

1903. MAYO, CHARLES H., M.D., Rochester, Minn. Surgeon to St. Mary's Hospital.

1899. MAYO, WILLIAM J., A.M., M.D., F.R.C.S. EDIN., LL.D. TOR., 427 West College Street, Rochester, Minn. Surgeon to St. Mary's Hospital. *Vice-President*, 1903.

*1880. MEARS, J. EWING, A.M., M.D., 1535 Land Title Building, Philadelphia. *President*, 1893; *Recorder*, 1881–93.

1901. MEYER, WILLY, M.D., 700 Madison Avenue, New York. Professor of Surgery in the New York Post-Graduate Medical School and Hospital; Attending Surgeon to the German and New York Skin and Cancer Hospitals; Consulting Surgeon to the New York Infirmary for Women and Children.

1893. MIXTER, SAMUEL JASON, S.B. (Massachusetts Institute of Technology), M.D. (Harvard), 180 Marlborough Street, Boston. Surgeon to Massachusetts General Hospital and to Carney Hospital; Consulting Surgeon to the Massachusetts Charity Eye and Ear Infirmary; Instructor in Surgery in the Harvard University.

1896. MONKS, GEORGE HOWARD. A.B. (Harvard), M.D. (Harvard), M.R.C.S. Eng., 67 Marlborough Street, Boston. Junior Visiting Surgeon, Boston City Hospital; Lecturer on Surgery, Harvard Medical School and Harvard Dental School.

1895. MOORE, JAMES E., M.D., 704 Pillsbury Street, Minneapolis, Minn. Professor of Surgery, University of Minnesota; Surgeon-in-Chief to the Northwestern Hospital. *Vice-President*, 1905.

1898. MORTON, THOMAS S. K., M.D., School Lane, Germantown, Philadelphia.

1904. MUDD, HARVEY G., M.D., 2604 Locust Street, St. Louis, Mo. Professor of Fractures and Dislocations and Clinical Surgery, Medical Department, Washington University; Surgeon to St. Luke's Hospital; Consulting Surgeon to the St. Louis City Hospital.

1906. MUMFORD, J. G., M. D., 29 Commonwealth Ave., Boston, Mass. Instructor in Surgery, Harvard Medical School; Visiting Surgeon to the Massachusetts General Hospital.

ELECTED

1900. MUNRO, JOHN C., M.D., 173 Beacon Street, Boston. Instructor in Surgery, Harvard; Professor of Surgery, Tufts College Dental School; Assistant Visiting Surgeon, Boston City Hospital. *Vice-President*, 1905.

1902. MURPHY, JOHN B., A.M., M.D., 100 State Street, Chicago, Ill. Professor of Surgery, Medical Department of Northwestern University, Chicago Post-Graduate School and Hospital, and Chicago Clinical School; Attending Surgeon to Mercy Hospital, Cook County Hospital and Wesley Hospital; Consulting Surgeon to Alexian Brothers' Hospital and Hospital for Crippled Children.

1898. MURRAY, FRANCIS W., M.D., 32 West Thirty-ninth Street, New York City. Professor of Clinical Surgery in Cornell University Medical College; Surgeon to the New York and St. Luke's Hospitals.

1882. DE NANCRÈDE, C. B. G., A.M. (University of Pennsylvania), M.D., LL.D. (Jefferson), 720 South University Avenue, Ann Arbor, Mich. Professor of Surgery in the University of Michigan; Professor of Surgery, Dartmouth Medical College. *Vice-President*, 1889 and 1899.

1903. NEILSON, THOMAS R., M.D., 122 South Seventeenth Street, Philadelphia, Pa. Surgeon to the Episcopal Hospital and to St. Christopher's Hospital for Children; Clinical Professor of Genito-Urinary Diseases in the University of Pennsylvania.

1900. OCHSNER, A. J., B.S., F.R.M.S., M.D. Eng., 710 Sedgwick Street, Chicago. Professor of Clinical Surgery, College of Physicians and Surgeons; Surgeon-in-Chief of Augustana and St. Mary's Hospitals.

1900. OLIVER, J. C., M.D., 628 Elm Street, Cincinnati, Ohio. Dean and Professor of Operative Surgery, Miami Medical College; Surgeon, Cincinnati, Presbyterian, and Christ Hospitals.

1905. OVIATT, CHARLES W., M.D., 500 Algoma Street, Oshkosh, Wis.

1882. OWENS, JOHN E., M.D., 1201 Venetian Building, Chicago, Ill. Professor of Principles and Practice of Surgery and Clinical Surgery in the Chicago Medical College; Surgeon to St. Luke's Hospital. *Vice-President*, 1900.

1899. PARHAM, FREDERICK WILLIAM, M.D., 1429 Seventh Street, New Orleans, La. Professor of General Clinical and Operative

ELECTED

Surgery on the Cadaver, New Orleans Polyclinic; Surgeon to Charity Hospital; Consulting Surgeon to Eye, Ear, Nose, and Throat Hospital.

1885. PARK, ROSWELL, A.M., M.D., 510 Delaware Avenue, Buffalo, N. Y. Professor of Surgery in the Medical Department of the University of Buffalo; Surgeon to the Buffalo General Hospital; Consulting Surgeon to the Fitch Accident Hospital. *President,* 1900; *Vice-President,* 1893; *Member of Council,* 1893–94, 1901–03.

1893. PARMENTER, JOHN, M.D., 519 Franklin Street, Buffalo, N. Y. Professor of Anatomy and Clinical Surgery in the Medical Department of the University of Buffalo; Surgeon to the Sisters of Charity, Erie County, Fitch, Children's, and Emergency Hospitals; Assistant Surgeon to the Buffalo General Hospital.

1889. PILCHER, LEWIS S., A.M., M.D., LL.D. (Dickinson), 145 Gates Avenue, Brooklyn, N. Y. Professor of Clinical Surgery in the Post-Graduate Medical School, New York; Surgeon to the Methodist Episcopal Hospital, New York. *Vice-President,* 1893.

1904. PORTER, CHARLES ALLEN, A.M., M.D., 254 Beacon Street, Boston, Mass. Assistant Surgeon to the Massachusetts General Hospital; Instructor in Surgery, Harvard Medical School.

1887. PORTER, CHARLES BURNHAM, A.M., M.D. (Harvard), 5 Arlington Street, Boston, Mass. Professor of Clinical Surgery in Harvard University; Surgeon to the Massachusetts General Hospital. *Vice-President,* 1892.

1896. POWERS, CHARLES A., A.M., M.D., Fourteenth and Stout Streets, Denver, Col. Professor of Surgery in the University of Denver, and Surgeon to the Denver City and County Hospital and to St. Luke's Hospital; Consulting Surgeon to the Mercy Hospital and to the State Home for Children. *Vice-President,* 1903.

1886. RANSOHOFF, JOSEPH, M.D., F.R.C.S. ENG., 19 West Seventh Street, Cincinnati, Ohio. Professor of Anatomy in the Medical College of Ohio; Surgeon to the Cincinnati and the Good Samaritan Hospitals.

1887. RICHARDSON, MAURICE HOWE, A.B., M.D., 224 Beacon Street, Boston, Mass. Surgeon to the Massachusetts General Hospital; Assistant Professor of Clinical Surgery in Harvard University. *President,* 1902; *Vice-President,* 1897; *Secretary,* 1894–96; *Member of Council,* 1904.

ELECTED

1901. Rixford, Emmet, B.S., M.D., 1795 California Street, San Francisco, Cal. Professor of Surgery in Cooper Medical College; Surgeon to City, County, and Lane Hospitals. *Vice-President*, 1905.

1882. Roberts, John B., A.M., M.D., 313 S. 17th Street, Philadelphia. Professor of Anatomy and Surgery in the Philadelphia Polyclinic; Surgeon to the Methodist and Jewish Hospitals. *Vice-President*, 1888 and 1894: *Treasurer*, 1892–93.

1898. Rodman, William L., A.M., M.D., 1904 Chestnut Street, Philadelphia. Professor of the Principles of Surgery and Clinical Professor of the Principles and Practice of Surgery and Clinical Surgery in the Woman's Medical College, Philadelphia; Professor of Surgery, Medico-Chirurgical College, Philadelphia.

1882. Rushmore, John Dikeman, M.D., 129 Montague Street, Brooklyn, N. Y. Professor of Surgery in the Long Island College Hospital; Surgeon to the Brooklyn, St. Peter's, and the Eye and Ear Hospitals.

1882. Senn, Nicholas, M.D., Ph.D., LL.D. (Jefferson), 532 Dearborn Avenue, Chicago, Ill. Professor of the Principles of Surgery and Clinical Surgery in Rush Medical College; Surgeon to Presbyterian Hospital; Surgeon-in-Chief to St. Joseph's Hospital. *President*, 1892; *Member of Council* 1897.

1902. Shepherd, Francis J., M.D., 152 Mansfield Street, Montreal, Canada. Professor of Anatomy and Lecturer on Operative Surgery in McGill University, Montreal; Senior Surgeon to the Montreal General Hospital.

1905. Sherman, Harry M., A.B., A.M., M.D., 2125 Jackson Street, San Francisco, Cal. Professor of Surgery in the University of California; Surgeon to St. Luke's Hospital, San Francisco; Orthopedic Surgeon to the Children's Hospital, San Francisco.

1895. Souchon, Edmond, M.D., 2403 St. Charles Avenue, New Orleans, La. Professor of Anatomy and of Clinical Surgery, Tulane University; Surgeon to Charity Hospital; Consulting Surgeon to the Eye, Ear, Nose, and Throat Hospital. *Vice-President*, 1899.

1900. Taylor, William J., M.D., 1825 Pine Street, Philadelphia. Surgeon to the Orthopædic Hospital and Infirmary for Nervous Diseases, and to St. Agnes' Hospital; Consulting Surgeon to the West Philadelphia Hospital for Women.

ELECTED

1882. THOMSON, WILLIAM, M.D., 1426 Walnut Street, Philadelphia. Emeritus Professor of Ophthalmology in the Jefferson Medical College.

1882. TIFFANY, LOUIS MCLANE, A.M. (Cantab.), M.D., 831 Park Avenue, Baltimore, Md. *President*, 1895; *Member of Council* 1883–89 and 1896–97.

1882. VANDER VEER, ALBERT, A.M., M.D., Ph.D., 28 Eagle Street, Albany, N.Y. Dean of Albany Medical College; Professor of Didactic Abdominal Surgery and of Clinical Surgery in the Albany Medical College; Consulting Surgeon to St. Peter's Hospital; Attending Surgeon to the Albany Hospital. *President*, 1905; *Vice-President*, 1898.

1902. VAUGHAN, GEORGE TULLY. M.D., 1718 I Street, Washington, D. C. Professor of Principles and Practice of Surgery, Georgetown University; Professor of Surgery and Genito-Urinary Surgery, Washington Post-Graduate Medical School; Chief Surgeon, Georgetown University Hospital; Surgeon, Emergency Hospital; Consulting Surgeon, Government Hospital for the Insane, Washington, D. C., Assistant Surgeon-General, U. S. Public Health and Marine Hospital Service.

1891. WALKER, EDWARD W., M.D., 30 Garfield Place, Cincinnati, Ohio. Professor of Surgery, Miami Medical College.

1882. WARREN, JOHN COLLINS, M.D., LL.D. (Jefferson), HON. F.R.C.S. ENG., 58 Beacon Street, Boston, Mass. Professor of Surgery in Harvard University; Surgeon to the Massachusetts General Hospital. *President*, 1896; *Vice-President*, 1890; *Member of Council*, 1897.

1896. WATSON, FRANCIS SEDGWICK, A.B., M.D., 92 Marlborough Street, Boston. Surgeon to the Boston City Hospital; Instructor in Genito-Urinary Surgery, Harvard Medical School.

1889. WEEKS, STEPHEN H., M.D., 662 Congress Street, Portland, Maine. Emeritus Professor of Surgery in the Medical School of Maine; Surgeon to Maine General Hospital. *Vice-President*, 1903; *Member of Council*, 1893.

1889. WEIR, ROBERT F., A.M., M.D., HON. F.R.C.S. ENG., Cor. Mem. Surg. Soc., Paris, 11 East Fifty-fourth Street, New York. Professor of Surgery in the College of Physicians and Surgeons, Columbia University; Surgeon to the Roosevelt Hospital. *President*, 1899; *Member of Council*, 1893–1896, 1901–03.

ELECTED

1892. WHARTON, HENRY R., A.M., M.D., 1725 Spruce Street, Philadelphia. Surgeon to the Presbyterian, Children's, and Methodist Hospitals.

1882. WHITE, J. WILLIAM, M.D., Ph.D., 1810 South Rittenhouse Square, Philadelphia. John Rhea Barton Professor of Surgery in the University of Pennsylvania.

1882. WILLARD, DE FOREST, A.M., M.D. (Univ. of Pa.), Ph.D., 1818 Chestnut Street, Philadelphia. Professor of Orthopedic Surgery in the University of Pennsylvania; Surgeon to the Presbyterian Hospital; Consulting Surgeon to the Germantown Hospital; the Atlantic City Hospital; the Jewish Hospital; the Phœnixville Hospital; and the South Mountain Hospital. *President*, 1901; *Recorder*, 1893–1900; *Member of Council*, 1901–04.

1901. WOOLSEY, GEORGE, M.D., 117 East Thirty-sixth Street, New York City. Professor of Anatomy and Clinical Surgery, Cornell University; Surgeon to Bellevue Hospital; Associate Surgeon to the Presbyterian Hospital.

HONORARY FELLOWS.

ELECTED

1885. ANNANDALE, THOMAS, M.R.C.S. ENG., M.D. EDIN., 34 Charlotte Square, Edinburgh, Scotland. Regius Professor of Clinical Surgery in the University of Edinburgh.

1905. BILLINGS, JOHN S., M.D., 40 Lafayette Place, New York, N. Y.

1894. VON BERGMANN, SR., EXCELLENZ, HERR NIRKL, Geh. Med. Rath., Klin. Institut für Chirurgie, Berlin, Germany.

1891. BRYANT, THOMAS, ESQ., F.R.C.S. ENG., 65 Grosvenor Place, Grosvenor Square, W., London.

1891. CHIENE, JOHN, F.R.C.S. EDIN., M.D. EDIN., 26 Charlotte Square, Edinburgh, Scotland. Professor of Surgery in the University of Edinburgh.

1885. CZERNY, PROF. DR. VINCENT, 25 Sophien Strasse, Heidelberg, Germany. Professor of Surgery in the University of Heidelberg.

1885. VON ESMARCH, NIRKL, PROF. DR. FREIDRICH, 2 Hospitalberg, Kiel, Schleswig–Holstein, Germany. Professor of Surgery in the University of Kiel.

1891. HARRISON, REGINALD, ESQ., F.R.C.S. ENG., 6 Lower Berkeley Street, Portman Square, W., London.

1890. HORSLEY, SIR VICTOR ALEXANDER HADEN, F.R.C.S. ENG., 25 Cavendish Square, W., London.

1894. KOCHER, PROF. DR. THEODOR, Professor of Surgery, University of Berne, 25 Villette, Berne, Switzerland.

1885. LISTER, LORD JOSEPH, F.R.C.S. ENG., D.C.L., LL.D., 12 Park Crescent, London, N. W. Professor of Clinical Surgery in King's College.

1894. MACEWEN, SIR WILLIAM, M.D., Mast. Surg., 3 Woodside Crescent, Glasgow, Scotland.

ELECTED

1903. Robson, A.W. Mayo, M.D., F.R.C.S., D.Sc., 8 Park Crescent, Portland Place, London, W., England. Vice-President, Royal College of Surgeons of England; Hunterian Professor of Surgery and Pathology.

1882. Smith, Stephen, A.M., M.D., LL.D., 574 Madison Avenue, New York. Professor of Clinical Surgery in the University Medical College of New York; Surgeon to the Bellevue and the St. Vincent's Hospitals. *Vice-President*, 1890.

1896. Terrier, Dr. Felix, 11 Rue de Solferino, Paris, France. Professor of Operative Surgery in the Faculty of Medicine of Paris; Surgeon to the Hôpital Bichat.

REPORT OF THE COMMITTEE ON NECROLOGY.

PHINEAS J. HORWITZ, M.D.

PHINEAS J. HORWITZ was born at Baltimore, Maryland, March 3, 1822. He was the son of Dr. Jonathan Horwitz, who was a man of learning and of an old Maryland family. Dr. Horwitz received his early education in the private schools of Baltimore and subsequently graduated from William and Mary College. He received his medical degree at the University of Maryland in March, 1845, and, after passing the examinations of the Medical Department of the Navy, was appointed Assistant Surgeon November 18, 1847. He served continuously and with distinction from that date until his retirement in 1884, when he was placed on the retired list.

Dr. Horwitz's service while in the Navy was extremely active and arduous. Immediately after his entrance into the service of the United States he was sent to Mexico with the Fleet under the command of Commodore Perry, from which distinguished Officer he received personal commendation and thanks for his efficient and energetic services. While in Mexico he was placed in charge of the Naval Hospital at Tobasco, and remained there until the close of the War. Subsequently he was detailed to the Frigate "Constitution," and served on the Mediterranean Station, and afterward on the "Relief," "Princeton," and "Supply," on which different vessels he did duty on many stations of the Service. Upon his return from the African Cruise in 1859, he was assigned to duty as Assistant in the Bureau of Medicine and Surgery, and on this duty he remained throughout the entire War. The whole system of tabulating the casualties of War, of indexing the books of reference, certificates of disability and disease, was designed and carried forward by Dr. Horwitz, so that there was probably no case of injury, disease, or disability that occurred during his connection with the Bureau that will not be found in its appropriate place in the Medical Department of the Navy. During the War the clerical force of the Bureau

was not increased, although the work of that Department was large and the greater part of the labors fell immediately upon the shoulders of Dr. Horwitz. It was a matter of great pride with him that all of this work was done without the aid of a single additional clerk.

Dr. Horwitz was appointed on July 1, 1865, Chief of the Bureau of Medicine and Surgery of the Navy, with the relative rank of Commodore. He served in this position until July 1, 1869, and, while Chief of the Bureau, he projected and built the Naval Hospitals at Philadelphia, and Mare Island, California. After serving four years in this position, he was stationed almost exclusively in the City of Philadelphia, having charge of the Naval Hospital there, and also serving as President of the Naval Examining Board. He was promoted to the grade of Medical Director on December 9, 1873, being the highest grade of his corps, and was retired in 1884, and remained in the Navy until the date of his death, September 28, 1904, having had active service in the United States Navy for a period of thirty-eight years, and having been an Officer of the Service for fifty-eight years.

Dr. Horwitz was an intimate friend of the late Dr. Samuel D. Gross, the Founder of the American Surgical Association. He was one of the pall-bearers at the late Dr. Gross' funeral, and accompanied the remains to the Western part of the State of Pennsylvania, to the Crematory, which was then the only one existing in the East. It was at this time that Dr. Horwitz became impressed with the beauty of cremation, as well as its scientific utility, and left a request that he himself should be cremated. This was done, and the ashes were buried in Philadelphia on October 1, 1904.

Dr. Horwitz, in his lifetime, was on terms of friendship with many of the distinguished men of the day, including President Lincoln, Gideon Wells, Secretary of the Navy during the War; Capt. Gustavus Fox, William E. Faxson, William E. Chandler, at one time Secretary of the Navy and subsequently Senator from New Hampshire, and the foremost men at Washington in the War time. It was in some measure due to Dr. Horwitz that the attempt to impeach President Johnson was not successful. Amongst Dr. Horwitz's patients was Senator Grimes, who was ill at the time that the vote was to be taken in the Senate upon the impeachment of the President. Dr. Horwitz was

successful in getting the Senator in a sufficiently strong condition to be taken to the Senate, and he himself supported the Senator when he voted in favor of sustaining President Johnson.

Dr. Horwitz took an active part in the work of the Medical Department of the Navy. He helped to draft the Navy Retirement Bill, fixing the age limit at sixty-two years, and also the Bill fixing the relative rank and pay of the Officers of the Line and Staff. He did much to systematize the entrance examination to the medical corps, and it was due to him that the orders were promulgated that applicants for positions in the Medical Corps of the Navy should be informed immediately as to whether or not they had passed their examinations, instead of being kept waiting for a long period of time, which was the old-fashioned custom.

After the Mexican War, while he was stationed in Philadelphia, Dr. Horwitz met and married Miss Caroline Norris, the daughter of Joseph Parker Norris, and descendant of the old Provincial Councillor. His wife pre-deceased him by many years, and Dr. Horwitz left surviving him three children, Dr. Orville Horwitz, who is Professor of Genito-Urinary Surgery at Jefferson Medical College; George Quintard Horwitz, lawyer, of the City of Philadelphia; and Mrs. S. Frank Sharpless, of the city of Philadelphia; and one grandchild, Caroline Norris Horwitz, the daughter of his second son.

He was a member of a number of medical and other societies, and one of the original members of the Military Order of the Loyal Legion, of which organization he was at one time Senior Vice-Commander in the State of Pennsylvania.

J. E. M.

THEODORE F. PREWITT, M.D.

Dr. Theodore F. Prewitt died at his home in St. Louis, October 17, 1904, aged seventy-two years. He was born in Fayette, Howard County, Mo., March 1, 1832, the son of Joel and Mary Trimble Prewitt. Being one of a family of eleven children, he was thrown upon his own resources at the early age of fourteen, his father having died. By his own industry and perseverance he continued educating himself until he was enabled to teach school. This he did for a number of years. Later he entered the St. Louis Medical College, and was graduated from that institution in 1856. In 1862 Dr. Prewitt came to St. Louis, and in 1871 was appointed Superintendent of the City Hospital. This position he held for three years, at the expiration of which time he resigned in order to continue his studies abroad.

On returning to St. Louis he was elected to the Professorship of Surgery in the Missouri Medical College. Later he served as Dean of that Faculty.

On the consolidation of the Missouri Medical with the St. Louis Medical College, forming the Medical Department of Washington University, Dr. Prewitt continued to fill the same professorship until the time of his death. During the last year of his life, however, his failing health prevented his taking an active part in the teaching staff.

For twenty-five years Dr. Prewitt was surgeon to St. John's Hospital, and the large surgical clinic built up at the institution during that time was an evidence of his earnest and self-sacrificing devotion to the work there.

In addition to being a member of the American Surgical Association, the St. Louis Surgical Society, the St. Louis Obstetrical Society, the St. Louis Medical Society, and the Missouri State Medical Association, Dr. Prewitt was a fellow of the Philadelphia Academy of Surgery. He was one of the original members of the St. Louis Surgical Society, and served as its Treasurer until 1903.

Dr. Prewitt was always a hard worker and an earnest student. Even in later years his professional study was by no means confined to surgical

subjects, but he enjoyed extending his researches into all departments of medicine. As a teacher he was clear, candid, and effective. As a surgeon he was well-informed and resourceful, and his successes, extending over many years of practice, richly attest to the intelligent earnestness with which he conducted his work.

N. B. C.

WILLIAM GIBBS PORTER, M.D.

Dr. William Gibbs Porter was born in the city of Philadelphia April 25, 1846. His early education was acquired in private schools. Afterward he entered the University of Pennsylvania, in which he spent the Freshman and Sophomore years with the Class of 1867. Abandoning his academic studies he entered the Medical Department of the University of Pennsylvania, and after a three years' course graduated as Doctor of Medicine in 1868. He was immediately elected Assistant Resident Physician to the Philadelphia Dispensary, where he remained for one year, acting also as Surgeon to the Central Police Station. The next fifteen months he spent as one of the Resident Physicians to the Philadelphia Hospital. He was one of the Visiting Surgeons to the Philadelphia Hospital for twenty-five years; Out-door Physician to the Guardians of the Poor, Vaccine Physician to the Charity Hospital, and Dispensary Surgeon to St. Mary's Hospital. He was Visiting Surgeon to the Presbyterian Hospital from its foundation in 1872 until 1904, when he was compelled by ill health to resign and was made Surgeon Emeritus in appreciation of his long and faithful service.

He was a member of the Philadelphia Pathological Society, of which he was Secretary for four years; a Fellow of the College of Physicians, of which he was Secretary for two years; a member of the Philadelphia County Medical Society; the Pennsylvania State Medical Society; the Obstetrical Society of Philadelphia, the American Medical Association; and Fellow of the Philadelphia Academy of Surgery, of which he was Treasurer for many years, and of the American Surgical Association.

During the great railroad riots in 1877 he was Brigade Surgeon, with the rank of Major, in the National Guards of Pennsylvania.

He was married on April 21, 1880, to Miss Susan Miles Hobart, of Fairfield, Connecticut. There are five living children—two sons and three daughters. He died on January 30, 1906, of pneumonia, at Old York Road, Oak Lane, where he had been residing for the previous few months.

WILLIAM SMITH FORBES.

Dr. William Smith Forbes, for many years a member of this Association, died suddenly of angina pectoris, on December 17, 1905, at his home in Philadelphia.

Dr. Forbes was born in Falmouth, Stafford County, Va., on February 10, 1831. He was educated at Fredericksburg and Concord Academy and spent his first year in medicine at the University of Virginia, 1850-51. He was a pupil of Dr. George Carmichæl. He completed his medical studies and graduated at the Jefferson Medical College in 1852; during and subsequent to this time he was a pupil and one of the assistants of the late Dr. Joseph Pancoast. He was elected resident of the Pennsylvania Hospital September 26, 1853, and during his residency matriculated at the University of Pennsylvania. He received his degree from the University of Pennsylvania in 1866.

Dr. Forbes served with the English Army in the Crimean War as surgeon in the Military Hospital of Scutari, Constantinople, and was offered on his return the Medical Directorship by the British Government. This, however, was refused because its acceptance would have made it necessary for him to relinquish his American citizenship.

On his return to this country Dr. Forbes opened a private school in 1857 at Tenth and College Avenue, where he taught anatomy and operative surgery until 1872. He was professor of Anatomy in the Pennsylvania Dental College and in 1879 was elected Demonstrator of Anatomy in Jefferson Medical College; in 1886, he was elected Professor of Anatomy and Clinical Surgery in that institution, which position he held at the time of his death.

As a teacher Dr. Forbes enjoyed to a high degree the respect, confidence and good-will of his students. There was not a member of Jefferson Faculty to whom they were more wont to apply for help and advice than to him; indeed—he was always mentioned as "a friend of the boys."

For twenty-five years, from 1862 to 1887, Dr. Forbes was visiting surgeon to the Episcopal Hospital, and in surgical matters his name is best known in connection with litholapaxy. His work in determining

the resisting power of vesical calculi to crushing instruments was entirely original. The lithotripe which he devised and described to the members of this Association at the meeting in 1894 is an instrument of great strength and one which conforms better to the laws of mechanics than any yet produced. Dr. Forbes was also the first surgeon to divide the accessory tendons of the extensor communis digitorum for the purpose of freeing the ring finger. A simple procedure, which has been greatly appreciated by musicians, for whose benefit it was devised. He performed this operation upward of four hundred times.

During the War of the Rebellion he entered the medical service as an acting assistant surgeon and served throughout the Rebellion, reaching the rank of Medical Director of the Thirteenth Army Corps.

In all his positions he conducted himself with credit so as to be favorably regarded, not only by men of his own profession, but also by his fellow-men.

In addition to his recognition as a surgeon, teacher, investigator, Dr. Forbes was well known as the author of the Anatomy Act of Pennsylvania and was one of the members of a committee of three, created by the College of Physicians, to advocate the passage of this Act because of his abhorrence of the desecration of the sepulchre. This first Act was only applicable to the counties of Philadelphia and Allegheny. And, curiously, the irony of fate made this man suffer in 1882 for supposed complicity in grave-robbing, while in the line of his duty as a teacher in Jefferson College; he was, however, acquitted and the Act of 1883 was made applicable to the entire State of Pennsylvania, making it mandatory for the delivery of the unclaimed dead.

Dr. Forbes was a scholar and a man of culture, a practical man of wide attainments and resources; his manners were kind and courteous. He was thoughtful of others and gentle toward the young. He was a fitting representative of that class, who while with us enjoy the admiration and respect of their associates. He was a conspicuous example of a type fast passing away from among us, the cultured gentleman of the old school.

He is survived by a wife and six children. His body was cremated and his ashes were taken to Fredericksburg to the family ground.

ADDRESS OF THE PRESIDENT.

INTRODUCTORY REMARKS AND REPORT OF A SERIES OF CASES OF MALIGNANT GROWTHS, WITH A CLINICAL STUDY OF THE POSSIBILITIES OF CARCINOMA AND SARCOMA APPEARING IN THE SAME PATIENT.

By ALBERT VANDER VEER, M.D.,
ALBANY, NEW YORK.

THERE is much in the organization we represent I would like to review. Well do I call to mind the thoughts and views the elder Gross held, when considering the possibility of organizing the American Surgical Association. Could he have realized how great was to have been his reward, in the excellent work accomplished in less than a quarter of a century, what comfort would have been his. At Atlanta, at the Isles of Shoals, at other vacation resorts, in conversation, this is the association he prophesied would, in time, represent the surgery of this country.

For me to review historically all that has been accomplished, and of which I have been personally cognizant, would indeed be "bringing coals to Newcastle." Some of you, in most forceful reviews, have covered the ground; others have had the advantage of reading these admirable addresses, and the education of the younger men has been augmented by access to our priceless volumes.

Of the impressive periods, and of the greatest value, I would recall two meetings, one of which early recognized the importance of bacteriological work, with the establishing of laboratories for research and pathological investigation; the other, where

the able and careful discussion of the question of exploratory laparotomy resulted in its endorsement and recommendation. Never will I forget this scene, when gray-haired surgeons were willing under proper surgical technique to freely open the peritoneal cavity and gave their consent to the performance of operations they had hitherto believed too hazardous, and, in fact, impossible.

In this atmosphere of my professional retrospective buoyancy, permit me to express to you my gratitude for your confidence in electing me your presiding officer.

Deeming it not out of place, let me congratulate you upon the final disposition of the question of membership, in such a manner as to retain all the loyalty and attendance of the senior Fellows and allow the election of a fair number of vigorous young and middle-aged men.

Also I would most earnestly call your attention to the geographical distribution of the Fellows elected in the past. In the United States are fifty cities ranging from 50,000 up to 321,000 inhabitants, also there are several cities in Canada having a like census, that have no representation in our association. It is fair to assume, and in fact we know, that a great majority of these cities contain good hospitals and, in some instances, a well-organized medical college. In the advancement, as Senior Fellows, and in the addition of a larger number of new men, ought we not to consider somewhat more carefully geographical claims, other conditions being equal? There are certainly many able surgeons in this unrecognized territory who could add much regarding racial and climatic influences upon general surgery, hitherto somewhat neglected. In presenting these views I would in no way lessen the value of the work done by brave, well-prepared men in smaller towns. We know full well that some of our ablest Fellows are from the latter places, and in recognition of their great success they, in return, have added immensely to the worth and prominence of the association.

For many years I have had in mind the possibility of the duality

of malignant disease, that is, as to carcinoma and sarcoma presenting in the same patient, and as to the genesis of many cases appearing in the same family.

With these thoughts in mind I wish to present the following observations: To this subject I was first attracted by the case of Mrs. P. R., aged fifty-seven years, who presented March 20,

Mrs. P. R., aged fifty-seven years. Acute carcinoma of left breast; sarcoma of dura mater.

1870, with acute carcinoma of the left breast, and who, while being prepared for operation, was suddenly seized with a convulsion, ending in immediate death. An autopsy revealed a tumor from the dura, extending outward, ulcerating nearly through the cranium, and which caused deep pressure upon the brain substance. (See illustration).

No other growths were found in the brain, and, aside from the left breast, all other organs were in a healthy condition. A microscopic examination made of the brain tumor, at the time, together with the macroscopic appearances, classed it as a sarcoma. The microscopic examination of the tumor from the breast was positively that of acute scirrhus or carcinoma.

Years passed by and though many cases were observed, giving all the phases of malignant growths, yet no picture presented itself like that carried in my mind of carcinoma and sarcoma appearing in the same individual.

In May, 1880, I was called to see Miss C. J., aged fifty years. She had passed her menopause without any complications, but for nearly two years had noticed a growth in her left breast, which she had shown to no one until now, when the ulcerative odor had attracted attention, and on examination by her physician he found a carcinoma far advanced. There were large masses in the axilla and in the supra and infra clavicular spaces. No operation was possible, the patient dying June 10, 1880, from sepsis. There was no autopsy.

Her family history was of interest. Her father, aged seventy-three years had recently died from an extensive and long-standing epithelioma of the lip and face, which had involved the glands of the neck. He had never permitted treatment of any kind or in any form. Mr. J. had previously lost a brother, at the age of fifty-six years, with some form of malignant disease of the foot, and who had been ill for a long time. Otherwise Miss J.'s family history seemed excellent. Her mother, aged seventy years, was in good health and gave a good family history, but died later from some kidney complication.

Some time after the death of the first, and eldest, sister, I was called to see the second sister, Miss D. J., aged fifty-three years, with a good personal history, and who a few months previously had noticed a tumor in her left breast. On examination it was plainly a case of movable, acute carcinoma, without axillary complications. An immediate operation was advised and agreed to. The operation was very thorough, extending far up in the

axilla, but not removing the pectoral muscle. She remained well for about fifteen months when a few nodules appeared in the cicatrix, which ulcerated, giving her little annoyance, but within a short time, September 9th, 1886, she died from metastases in the liver and stomach. No autopsy was held. Examination of the tumor removed classed it as a case of acute scirrhus. The lessening of her sufferings, as compared with her sister's case, made a very profound impression upon her family and friends.

In May, 1899, I saw Mrs. E. J., aged fifty years, a fourth sister in age, married, mother of one child, whom at birth she had nursed for a few months without any mammary complications. Several weeks previous to my visit she had noticed a tumor in left breast, associated with sharp, lancinating pains, retraction of the nipple and all the symptoms which she had noticed in her sisters' cases. She was greatly disturbed, but, with her husband, readily agreed to a prompt operation, which I made equally as thorough as in the last case, doing it at the home of the patient.

She remained well until January, 1903, when I was again summoned to see her, as she had, a few days previously, called her physician's attention to marked abdominal pain. Upon examination it was very evident she was suffering from an ovarian cyst. She entered the Albany Hospital at once and at operation a multilocular cyst was found connected with the left ovary. Pathological examination of the tumor removed demonstrated it an ovarian cyst with secondary papillomatous and carcinomatous degeneration. Right ovary and appendix normal.

Following this operation Mrs. J. gained greatly in health and flesh and made an European trip.

In May, 1904, I was again called to see her. Two weeks previously she began to suffer with severe abdominal pain, abdomen tender to touch and some slight nausea. She entered the Albany Hospital, January, 25, 1904, and after preparation I operated on the morning of the 26th. Incision revealed a large cyst connected with the right ovary. This was aspirated, but cyst wall was found so thoroughly adherent to the surrounding tissues, including appendix, head of cæcum and small intestines, that it was found

impossible to remove it entirely. The greater portion was excised and laboratory examination revealed the same general characteristics as the previous tumor of the left ovary.

She was discharged from the hospital February 19, 1904, and improved after this, being quite comfortable until within two weeks of her death, which occurred October 20, 1904. There was no autopsy, but every evidence of the mesenteric glands and stomach being involved. The breast scar showed no return of the growth and in every way she had enjoyed perfect use of her arm.

In April, 1897, I saw in consultation, Mr. H. J., aged fifty-six years, husband of Mrs. E. J., the case just reported, who presented a good family history. He gave a record of an enlargement of the right testicle, sarcomatous in character, and later confirmed by our pathologist. A thorough operation was done for removal of the diseased organ, and he remained well for years. There was no return of growth in cicatrix nor metastasis, as shown at the autopsy. Mr. J. died May, 1900, of arteriosclerosis and great dilatation of heart.

In September, 1897, I had seen the third sister in this family, Mrs. F. J., aged fifty-one years and mother of six children. At that time she called my attention to a sore she had noticed under right breast, in the flexure of the skin, which had existed for several months, and which frightened her greatly. It had all the appearance of a true epithelioma. She begged not to have knife used and I treated it with Vienna caustic and arsenious acid paste. The ulcer healed kindly and remained well, she passing her menopause without any growths appearing elsewhere.

From May, 1903, I had this same patient, Mrs. F. J., under observation for prolapse of the uterus, second degree, with a constant leucorrhœal discharge, occasionally tinged with blood. I made a number of careful examinations and was unable to locate any malignant growths. Under the use of douches and the wearing of a rubber ring-pessary she was made very comfortable. She begged of me not to mention an operation, saying she was "too old," and then "you know what our family history is." October, 1905, she noticed a small tumor in left breast. After

examination I had not the courage to tell her my worst fears; however, I kept close watch of the growth and on January 10, 1906, insisted upon an immediate operation. Passively she consented, and the operation was done at the Albany Hospital three days later. She was now sixty years of age. I did a thorough dilatation and curettement of the uterus, repair of perineum, removed several hemorrhoids and while under ether made a complete examination of pelvis and abdomen. There was no abnormal condition present. I then removed the left breast and contents of axilla.

Microscopic examination at the laboratory showed the case to be carcinoma of the breast, with metastasis to lymph nodes; chronic endocervicitis, with papillomatous proliferation of surface epithelium.

Patient made a good recovery, normal in every respect.

In May, 1896, Miss G. J., daughter of Mrs. F. J., the third sister whose case I have just reported, met with a severe accident, accompanied with concussion of the brain. She, however, made a good recovery. Later she passed through a severe attack of typhoid fever. Patient had always been a strong, bright, active girl, fond of outdoor sports. Not long after her convalescence shed eveloped epileptic seizures, at times very serious, then better; she lingered some years and died May 15, 1900, with marked symptoms of tumor of the brain.

I had transferred this patient to the care of a specialist, was absent from the city at the time of her death, and have been unable to get a copy of the postmortem notes; however, have been told that the case was considered to be one of sarcoma of the brain, or, as we would now call it, a glioma.

Here then is a history of cases very impressive.

The first, that of Mrs. P. R., acute carcinoma of the breast and sarcoma of the brain.

Though with the subject thoroughly in mind, and for the fifteen years following I did much autopsy work and had a large surgical practice, yet I seldom saw a case arousing my suspicions as to the duality of malignant disease. The group of remarkable

cases awakened my early thoughts and impressions. Certainly in the case of Mrs. E. J., the fourth sister, we had an acute carcinoma of the left breast, later an ovarian cyst giving the macroscopic appearances of sarcoma, yet upon microscopic examination proving to be carcinomatous degeneration; later a third operation, mostly exploratory, revealed the pelvis filled with a mass of the same character, yet carcinomatous from specimens removed.

In the case of Mrs. F. J., the third sister, we had clinically true epithelioma, yet nine years after the latter patient developed acute carcinoma of the left breast, with removal.

Her daughter's case is certainly one of great importance. Did her typhoid attack excite and aid in developing a condition of sarcoma, latent for a time after the traumatism?

Is it not a strange coincidence that the husband of Mrs. E. J., the fourth sister, should present a condition of sarcoma?

It will be borne in mind that all four of these sisters had more or less care of their father during his long illness. Did the mental atmosphere tend in the least to develop these malignant cases as well as that of the brother-in-law?

The fifth and youngest sister in the family group died at the age of fifty years from heart trouble, but she had previously been treated for a long period for some uterine disease, the exact nature of which I have been unable to ascertain.

Say what we may on the subject of heredity in malignant and other constitutional diseases, must we not admit there are apparently types of transmission that are beautifully shown in the histological studies between sarcoma and carcinoma?

In my early years of student life and practice it was my sorrow to witness the death in many a family of several of its members from transmitted consumption. To-day we understand fully the term "inherited tuberculosis." May we not hope that in studying groups of cases, such as I have presented in this paper, something will be brought to light which will help to unravel the mystery that surrounds the malignancy of carcinoma and sarcoma?

Can we ever hope that some day a serum may be discovered

that in its use will control and arrest such conditions as I have just reported?

It has often occurred to me that we cannot say it is due to heredity; yet what is the explanation to be made in those impressive cases that come to us, where we have multiple conditions of malignancy in the same family, following in one or more generations, and where we have reason to believe there is a variety of malignancies, under different classifications, springing up in the same patient?

In the study of these cases the thought of house infection is to be considered. The first two sisters were born in the house where the uncle passed much of his time, when suffering from malignant growth of the foot. The last two were born in the house and lived where the father was attacked with epithelioma of the lip and face, and was ill for a long time. Each of the houses referred to was old at the time of the birth of these children, one is yet standing; but in neither have I been able to learn of any more or other cases of malignancy.

It is somewhat interesting to note that of the four sisters it was the left breast implicated in each case.

The writer has a record, and has seen a number of cases, of carcinoma of the breast in females who had non-malignant fibroids of the uterus, and in operating for the former malignancy did not develop in the latter. He has also operated for both conditions, when the strength of the patient would admit, always bearing in mind the sympathy between these organs in malignancy of either.

As far as possible the writer has looked up the literature, which is exceedingly meagre, bearing on the subject of this paper, and desires to present the following extracts; also having in mind, as regards etiology, pathology and possible prophylaxis, the admirable work of Prof. Jensen, of Copenhagen, to whom was awarded the Walker Prize by the Royal College of Physicians and Surgeons.

Westminster Hospital Report, London, vol. xiv, pp. 324–327, 1905. Cases illustrating the occurrence of histologically different types of neoplasm in the same person.

Clinical Rep. Westminster Hosp., vol. iii, pp. 1335–1350. Amputation of right fore-quarter for large sarcomatous growth of axillary region. With tumor of right mamma and ulcer of right thumb. Note: It seemed at the time as if all three conditions were the same, but, histologically, there was absolutely no resemblance. Ulcer of thumb and axillary growth sarcomatous; breast tumor fibro-adenoma.

Westminster Postmortem Book, vol. xv, p. 203. Cancer of breast. Secondary deposits in brain, lungs, adrenals, kidney and bladder. Note: Growths in kidney and lungs sarcomatous.

Westminster Postmortem Book, vol. xv, p. 37. Case of carcinomatous stricture, with ulceration, at middle third of œsophagus. Note: Microscopically the greater part of growth showed a typical sarcomatous structure. No doubt but that the initial growth was, however, a squamous-celled carcinoma. Often there is great difficulty in deciding whether a growth, primarily, should be called sarcoma or carcinoma.

Deutsche med. Woch., vol. xxx, p. 49. Multiple primary tumors. In his article entitled, "Ueber multiple primartumoren," in the *Deutsche Medizinische Wochenschrift*, Prof. Dr. P. Grawitz bases the same on a case which showed:

(*a*) A uterine myoma.

(*b*) Sarcoma of the ligamentum latum with metastases.

(*c*) A carcinoma of small intestine.

Dr. Blackburn, *Pathological Supplement, Thirty-ninth Annual Report of Government Hospital for Insane*, U. S. A., 1894. Three entirely independent neoplastic growths in the same patient:

(*a*) Endothelial sarcoma of dura mater.

(*b*) Carcinoma of stomach.

(*c*) Round-cell sarcoma of right testicle.

Mr. C. F. Beadles, *Transactions Pathological Society*, London, vol. xlviii, p. 245, 1897. Carcinoma of right breast with sarcoma of skin of groin.

Edinburgh Medico-Chirurgical Society, December 2, 1896. Mr. Cathcart exhibited a specimen of melanotic sarcoma and

one of scirrhus carcinoma removed simultaneously from the same patient.

J. A. Wyeth, *New York Polyclinic*, vol. ix, pp. 84–86, 1897 Notes on three cases of sarcoma and carcinoma.

Griffen and Dartigues, *Bull. Soc. Anatom. de Paris*, vol. lxxiii, pp. 570–572, 1898. Primary cancer of esophagus and hemorrhagic sarcoma at the site of an old operation.

Dr. Haberer. Klinik von Eiselberg. Allgemeine Krankenhaus in Wien. *Archiv. f. klinische Chirurgie*, 1904, Band lxxv, p. 609. Sarcoma and carcinoma in the same person.

Dr. H. Landau. *München. med. Woch.*, 1905, No. 52 and No. 14, p. 650. Carcinoma and sarcoma in the same person.

Obendorfer. *München. med. Woch.*, 1905, vol. lii, pp. 1477–1481. Concerning the multiplicity of tumors.

Berlin. klin. Woch., April 16, 1906, No. 16. E. H. Bashford, M. D., Director of the Laboratory of the Imperial Cancer Research Fund, London. A few remarks on the methods of producing experimental cancer.

From Prof. Landau's clinic in Berlin, the author is indebted to Dr. Ludwig Pick, pathologist, for the statement that their records do not show a single case of dual malignancy. Dr. Pick, however, has searched the German literature and remarks at the small number of clinical investigations reported on this subject.

Prof. Errich Lexer, of Konigsberg, writes that for the past fourteen years, while serving as assistant to Prof. von Bergmann, no case has presented itself in the clinic with a dual malignancy. Speaking for his own clinic, now at Konigsberg, to which he has but recently been summoned, he can give no definite information.

Prof. Ludwig Rehn, of Frankfurt-on-the-Main, states that he has never met with a case of dual malignancy.

When one reviews the literature in its meagreness the doubt is raised if there has ever occurred, *clinically*, a dual malignancy in the same patient, at the same time, notwithstanding the several cases reported, apparently, in the affirmative.

From Prof. Ehrlich's investigations on mice, as to the pathogenesis of cancer, we learn, in brief that:

1. In several cases sarcoma and carcinoma were produced simultaneously in the same animal, apparently, but that the sarcoma seemed to succumb to the carcinoma and eventually disappear after several generations.

2. After some generations it was found impossible to vaccinate successfully with carcinoma a mouse whose parents had also been vaccinated.

3. From criss-crossing the tumors between rats and mice the tumor life was indefinitely prolonged.

From Dr. Haberer's paper I beg leave to cull the following references in the literature:

1. Klein, Jaresberichte des Geburtshilflich-gynäkologischen Institutes der Universität Wurzbürg für das Jahr 1889. *Münchener Med. Woch.*, 1890.

2. Kretz, Zwei malingue Neubildungen in einem Individum. *Wiener klin. Woch.*, 1893, No. 11.

3. Becker, Zur Casuistik multipler primärer Geschwülste. *Beiträge zur klinischen Chirurgie*, 1895, Band xiv.

4. Niebergall, Sarcom, Carcinom, Myon, und Schliempolypen an ein und damselben Uterus. *Archiv. f. Gynäkologie*, 1896, Band l.

5. Emanuel, Uber gleischzeitiges Vorkommen von Carcinom und Sarkom im Uteruskörper. *Zeitsch. f. Geburtshilfe u. Gynäkologie*, 1896, Band xxxiv.

6. Walter, Ueber das multiple, Auftreteten primärer, bösartiger Neoplasmen. Langenbeck's *Archiv.*, 1896, Band liii.

While I am not personally conversant with the papers I learn from Dr. Haberer's article that Prof. Hansemann, of Berlin, has mentioned a case of glioma of the brain, ulcerating stomach myxoma and liver sarcoma, in the same patient, reporting it in 1897 in an article entitled, "Die microskopische Diagnose bösartiger Geschwulste."

That Dr. Franque saw two cases of carcinoma and sarcoma occurring in the same uterus, which he reported in an article entitled, "Ueber Sarcoma uteri." *München. med. Woch.*, 1898, No. 41.

And, lastly, from Grunfeld we learn of a case of this description which he reports under the title "Pur Dupplicitat malinger protopatischer Tumoren." *München. med. Woch.*, 1901, No. 33.

In this same article by Dr. Haberer we note the report of a case occurring in the service of Prof. von Eiselberg, of spindle-celled sarcoma of the epiglottis, followed one and one-half years later by carcinoma of the tongue.

In the preparation of this paper the writer has been most profoundly impressed with the recent work being done by Doctors Park, Gaylord, Clowes and Baeslaek, of Buffalo, and which is certainly deserving of our careful study and confidence. It is earnestly to be desired that from their investigations, along with Prof. Jensen, Ehrlich and others, something may be discovered that, in its application to the human family, will relieve the fearful suffering that yet accompanies the malignancy of carcinoma and sarcoma.

From the frequent study of Ehrlich and others the author is prone to ask the question, whether an antitoxin will some day be found, say from carcinoma, that used in the human system will destroy sarcoma, or using that of sarcoma destroy carcinoma?

SURGICAL TREATMENT OF EPISPADIAS AND ECTOPY OF THE BLADDER.

By PROFESSOR DR. F. TRENDELENBURG,
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Mr. President and Gentlemen: Permit me to express to you, Mr. President, and to the members of the American Surgical Association, my sincere appreciation of your esteemed invitation to take part in these proceedings, and also to acknowledge my pleasure in being afforded an opportunity to deliver a paper before so many of the leading surgeons of the United States here assembled.

The repair of congenital defects of the urethra and bladder constitutes one of the most difficult and for that reason perhaps one of the most interesting chapters in plastic surgery, and if the outcome be successful it may be regarded with intense satisfaction. During the past fifty years many surgeons have occupied themselves with the solution of this problem and many have been the attempts to devise a method by the aid of which, even in the severe types of the deformity, a restoration of the normal bladder form and normal bladder function could be secured. Up to the present time, however, this ideal has not been reached.

In passing I desire to refer very briefly to some of the essential facts in the history of this subject. In uncomplicated cases of epispadias Dieffenbach effected a cure by freshening the edges of the opening and then uniting them by direct suture. Where the cleft extended into the bladder itself, he regarded operative interference as practically hopeless. Thiersch then introduced a method by which the defect was covered with a neighboring skin flap, and it

was he who first succeeded in producing in front of the bladder left everted an enclosed narrow space in which, by the aid of a special mechanical contrivance which exerted pressure on the neck of the bladder, the urine could be retained.

FIG. 1.—Ectopia vesicæ. Inguinal herniæ.

For more than twenty years I have endeavored to aid the direct union of the freshened edges, in cases of ectopia, by producing a separation of the pelvic bones at the sacro-iliac synchondrosis, in order to provide for a closer approximation of the two halves of the pelvis anteriorly at the symphysis and consequently of the edges of the

defect. Only a limited number of surgeons have made use of my method, because the bilateral separation of the os ilei from the sacrum was generally regarded as a very dangerous procedure, and the attempt to produce a bladder in this way which was capable of retaining the urine was not uniformly successful.

FIG. 2.—Ectopia vesicæ. Inguinal herniæ. Result of operation.

Although the latter fact cannot be denied, there is little occasion for fear as regards the separation of the pelvic bones in the manner indicated, if the operation is done before the seventh or eighth year. In adults the procedure is undoubtedly much more difficult and dangerous.

In abandoning the attempts to restore a normal bladder cavity recourse was again had to an idea first proposed by Simon, who suggested that the urine should be diverted into the lower portion of the intestinal canal. In this way there was developed the method now recognized by the name of Maydl, which is characterized by

FIG. 3.—Ectopia vesicæ. Result of operation.

the implantation of the ureters into the sigmoid flexure. The continence which is thus attained may be made to extend over several hours. One of the dangers however which is associated with this method is the production of a pyelonephritis, from the entrance sooner or later of some of the intestinal contents into the ureters.

Gersuny, Borelius, Müller, Muscatello and Wehr have all suggested various ingenious modifications for obviating this difficulty, but none have succeeded in entirely overcoming it. And aside from the actual danger to life, the unnatural manner in which the urine

FIG. 4.—Ectopia vesicæ Result of operation. Trendelenburg's method.

must be voided per anum constitutes a great annoyance, particularly to patients of the male sex.

I am quite convinced, therefore, that the advent of Maydl's operation has in no way arrested the further development of plastic surgery in this field, and I believe that very probably ureteral transplantation will again be abandoned and recourse be had to direct

suture of the edges of the deformity under discussion as the only means by which the normal relations can be restored. I myself have always adhered to this plan and I now ask your kind permission to describe what I have accomplished along these lines and in what respects I have failed.

FIG. 5.—Ectopia vesicæ. Result of operation. Power of retaining urine, afterward lost again. Trendelenburg's method.

As regards my cases of bladder ectopy which were operated upon years ago, I desire to say that there are two patients living whom I have had under observation almost continuously and a third who has been seen occasionally. In all three patients the defect, which

extended from the umbilicus down to the glans penis, is completely closed and no fistulous openings are present. The form and shape of the penis itself are moreover quite satisfactory. The bladder when distended consists of a spherical cavity lined with mucous membrane over its greater extent. The passage of small concretions is occasionally observed by these patients, but the tendency to calculus formation is by no means as marked as in certain cases operated upon by Thiersch which I have had occasion to examine. These patients suffered to such an extent from the production of calculi, incrustations and ulcerations in the irregular crypts of the bladder that they demanded operation by some other method for the relief of their condition.

Retention of the urine is not complete in any of my three cases. These young men therefore wear a contrivance supplied with a small spring which compresses the urethra at the root of the penis either from the front or the back. The patients are now students in college, they are not greatly inconvenienced by the apparatus and by proper care and attention they avoid the production of any odor which would serve to attract attention to their condition. If the spring is raised with the finger, the urine issues forth in a stream. On lying down it collects in the bladder without leakage. One of the men remains dry throughout the night; he may be awakened once or twice by the desire to urinate and even when he gets up he can voluntarily retain the urine for several minutes and then pass it naturally in a stream.

A fourth patient, a boy of five, could also, when he tried, retain his urine for several hours when standing or walking; but later on, after the time of his leaving the clinic, this ability was lost.

Both of the two cases last mentioned demonstrate that the physiological factors necessary both for retention and voluntary micturition are present and that they are merely prevented from functionating in a normal manner by certain mechanical conditions. The reason for the failure may be accounted for by the fact that the two sections of the pelvis which have been separated at the sacroiliac synchondrosis have a tendency to gradually resume their former positions; therefore the neck of the bladder and the prostatic

portions of the urethra, which are closely connected with the pubic bones, are pulled upon to such an extent that the muscular ring can no longer be brought into play.

I have made several attempts to overcome this difficulty by mobilizing the pubic bones with the help of the chisel or by dissecting

FIG. 6.—Epispadias with fissure of neck of bladder. Fissure of pelvis.

widely the attachments of the urethra and the neck of the bladder to the latter. In no instance of complete ectopia have I been favored however with a permanent result. Such a procedure moreover is apt to lead to the production of a dense scar along the vesical neck, which in the event of a later secondary operation will be found

a source of as great annoyance as the cicatrices in a harelip which has failed to heal by primary union.

In cases of epispadias associated with incontinence, as well as in patients who present only a partial ectopy involving merely the vesical neck, the prognosis is more favorable. In these transitional types between simple epispadias and ectopia vesicæ there is also lacking a proper union at the symphysis pubis, but the separation at this point is not so extensive and consequently there is much less lateral tension on the neck of the bladder and the urethra after operative closure.

It is well known that in certain cases of epispadias where the infundibulum is narrow the previously existing incontinence may be overcome by direct suture of the urethra after the free edges of the latter have been freshened. But even if the infundibulum is sufficiently large to admit the tip of the little finger and a slight prolapse of the posterior wall of the bladder follows either coughing or straining, there is still some hope that continence may be restored. It is merely necessary in such cases to bring about a narrowing of the muscular ring (around the neck of the bladder) by the excision of a sufficiently wide wedgeshaped section from the upper border of the infundibulum and then carefully closing the resulting gap with buried catgut sutures. If it is found after operation that the urine still fails to be fully retained, then it becomes necessary to repeat the procedure, a larger strip being taken than on the former occasion.

In cases marked by a broad infundibulum and a partial ectopy of the bladder it is advantageous to make use of the space between the pubic bones at the symphysis to gain approach to the vesical neck and the prostatic portion of the urethra, which may be thus more readily freed. A vertical incision is made through the skin over the region of the symphysis and carried down between the pubes to the anterior wall of the bladder and the infundibulum. By means of two strong sharp retractors the pubic bones may then be forced apart, and through the space thus gained, and with the patient in the elevated pelvic position, the trimming of the edges of the ectopic bladder and subsequent suture are greatly facilitated. Enough tissue should be removed to leave broad bleeding surfaces which

may then be approximated with catgut sutures. In the region of the neck of the bladder the edges are turned in and brought together with a suture similar to that employed by Lembert for the intestine. The calibre of the new urethra is controlled by a small catheter previously inserted, but this should be removed at the close of the operation,

FIG. 7.—Epispadias with fissure of neck of bladder. Fissure of pelvis.

otherwise it will exert a dangerous degree of pressure on the suture line. In place of it there may be substituted a small drainage tube, which is inserted through a special opening made in the anterior wall of the bladder. The suture of the skin wound then completes the operation.

I obtained in this manner a perfect result by only a single operation in a boy of twelve, to whom some of the photographs herewith presented refer. The *x*-ray discloses the cleft in the pelvis. The pictures of the genitals show clearly the broad infundibulum; one picture was taken during the operation and another depicts the urinary stream during voluntary micturition.

A few years ago I also had an opportunity of operating upon a female patient for epispadias. In women, as is well known, this condition is much more infrequent than in men. Gütschow was able to find only thirty-five instances of this deformity reported in the literature. Strange to say, there is no reference made in any of these cases to a cleft in the pelvis, although we must expect to find it, inasmuch as the condition is analogous to that in the male and as in the severe cases a cleft of the bony structure is certainly always present. In the absence of an *x*-ray examination this feature may however escape notice. In a little girl of five operated upon by myself, the separation at the symphysis amounted to three centimetres and the picture of the external genitals was the usual one associated with epispadias of a marked degree. The labia majora and minora were separated above, and at the anterior end of each labium minus was situated a half of the divided clitoris. Above the hymen one could look directly into the infundibulum, the inferior wall of which was lined with the mucous membrane of the widely gaping urethra. Through this infundibulum it was readily possible to introduce the little finger into the bladder. On straining a small section of the posterior wall of the bladder came into view. Years ago, according to the statement made by the child's parents, the greater portion of the bladder prolapsed through the opening. We had to deal, therefore, with an extreme degree of epispadias, but with only a partial ectopia of the bladder.

As there was a well-marked diastasis at the symphysis, and as a good union of both bladder and urethra was to be expected only if the lateral tension could be eliminated, the first step in the operation consisted of the bloody separation of the pelvic bones at the right sacro-iliac synchondrosis. It was found that this was sufficient to permit of the complete approximation of the two halves of

the pelvis anteriorly. The freshening of the edges and the suturing of the cleft in the neck of the bladder were carried out just as in the previous case and then the symphysis was wired. After healing took place the incontinence continued, because the urethra and the neck of the bladder were still too wide. The entire opera-

FIG. 8.—Epispadias with fissure of neck of bladder. Fissure of pelvis. Boy retains urine for two hours.

tion was therefore repeated a year later, the wire suture being first removed, the two halves of the pelvis forced apart, the urethra and the neck of the bladder incised and narrowed, and the silver wire suture finally replaced at the symphysis. The result of this pro-

cedure was continence during the day extending over several hours and complete retention during the entire night. The wire suture was the cause of the production of a fistulous tract, but the latter

FIG. 9.—Epispadias with fissure of neck of bladder. Fissure of pelvis. Boy retains urine for two hours.

closed when the suture, which had already cut its way through the bone, was extracted. And now after a period of six years the result is still perfectly satisfactory.

The question naturally arises, Why was not a similar effect obtained in cases of complete vesical ectopia? The explanation may be found in the fact that it is impossible in these cases to bring together the pelvic bones in front and to keep them permanently in position. Wiring of the bones, particularly in boys, cannot be advantageously employed because the wire comes in conflict with both the bladder and the penis. In younger children, moreover, the wire is very apt to cut its way through the tissues.

I am of the opinion that it would be wise to go back to the old idea advanced by Demme and Passavant, and to make an attempt to bring about the desired changes in the bony structures of the pelvis by orthopedic measures. The rapidly growing osseous tissues of the young do not offer much resistance to even slight degrees of pressure, provided it is constantly applied. The bone yields and gradually undergoes marked alterations in form and contour. Thus we find, in cases of congenital macroglossia with prolapse of the markedly hypertrophied tongue, that the constant pressure of this soft tumor on the anterior portion of the inferior maxilla is such that in the course of years the middle section of the lower jaw assumes an oblique position and the alveolar process with the incisor teeth is turned entirely forward and downward. Ordinary soft mucous nasal polypi, if large or numerous, are liable in young individuals to displace the bony framework of the nose and thus to produce marked facial deformity. And the effect of constant though comparatively slight pressure intentionally applied to infantile bones is well illustrated by the feet of the Chinese women. The mother begins, according to the statement of Perthes, the treatment of her daughter's foot at the age of five years, applying a bandage twice daily in such a manner that the foot is held in a position of plantar flexion. The bandage causes so little pain that the child does not even cry, and yet the treatment is so effectual that the growth of the foot is arrested to such a degree that complete fixation of this part in a position of abnormal plantar flexion results during the course of a few years.

There seems to be no good reason why, with the exercise of time and patience, the infantile pelvis may not be similarly moulded in

cases of vesical ectopia. Thus the mother may be directed to apply a snug and sufficiently wide rubber band around the child's pelvis and hips for some definite period during the day and night. If this be supplemented by operative division of the pelvic bones at the synchondrosis, it may be possible to bring together *permanently* in this manner the two halves of the pelvis and to convert the transversely placed oval defect of the abdominal wall into a narrow vertical slit. This would produce practically the same conditions which are present in epispadias associated with a partial ectopia of the bladder, and we should then expect to have the same satisfactory operative result as in the less severe types of the deformity.

Cases of vesical ectopia are quite rare and their treatment demands the exercise of much time and patience. It is only by the united labors of many investigators that substantial progress can be attained.

Perhaps my brief communication may be the means of stimulating further research in this country on the lines indicated, which I have come to regard as the only method which is likely to be rewarded by perfect results.

SURGERY OF THE LARGE INTESTINE.

By GEORGE E. ARMSTRONG, M.D.,
MONTREAL, CANADA.

The primal question in malignant disease of the large intestine, to which I wish more particularly to refer, is that of its early recognition. Here, as in other regions, the lowering of the immediate mortality rate and the securing of greater freedom from recurrence are to be made, rather in the development of ways and means for its early recognition in its incipient stage than in devising heroic operative procedures.

The earlier indications may be observed in a cancerous anæmia or cachexia in one group of cases; while in another, weight, discomfort or constipation may be the first sign of any departure from the normal state of health. The remarkably good general condition sometimes present in advanced disease has been noted, but no explanation seems to be forthcoming for it so far. The onset of anæmia in a person at or beyond middle life should be in itself a sufficient stimulus to a careful search for a probable cause. In malignant disease, in addition to the usual syndrome, it is coming to be recognized more and more generally, that there is, I think I may say in the great majority of cases, a certain amount of temperature. If it can be established, as I think it can, that a daily range of temperature from 98° to 100° is a regular accompaniment of malignant growth and its resultant toxemia, even before the growth has broken down and presented a surface denuded of epithelium and more or less adapted to absorbing, we may have a sign which may be of as much value in detecting the early stages of malignant growth in the large intestine and in other situations as a similar abnormal

range of temperature is in incipient tuberculosis. I think that presently we may find evidences in the blood that may prove to be of material assistance. The work of A. E. Wright suggests visions of great possibilities for the future in diagnosis and therapy.

The symptoms proceeding from the local condition, even in the earliest period, seem necessarily associated with narrowing of the bowel. Pain of a colicky character, associated with constipation and frequently recurring, makes a symptom complex referred to by Nothnagel as indicative of disease in the large intestine. Many of these patients have told me that their stools did not give the usual sense of comfort. They did not feel as if they had finished. In the presence of these suggestive symptoms, I believe that a careful and methodical search would discover a tumor in a larger number of cases than hitherto suspected. Malignant tumors of the large intestine are generally sensitive, but sometimes indeed most surprisingly insensitive. If carcinomatous, they are as a rule hard—stony hard. To this, however, I have recently had under observation a striking exception in the presence of a large soft tumor of the descending colon, not narrowing the lumen of the gut appreciably, and reported by the pathologist to be adenocarcinoma. Sarcomata, of course, are generally larger and softer. The search for these tumors should be methodical, and not considered complete until the patient has been examined on more than one occasion, and in the upright as well as in the recumbent position. A distinguishing feature of these tumors is their mobility. They may lie under the liver or under the spleen, so that they may not be detected with the patient in the recumbent position, and yet become apparent when the patient stands up; or they may be discoverable one day, and the next be impalpable in any position that the patient may assume. Their most characteristic feature is their extreme mobility under the hand, and this sign is always present unless they have formed adhesions. Visible movement is sometimes present during forced inspiration and during peristalsis. The mobility is particularly marked of course in the transverse colon

and sigmoid. In the examination of the blood, in the daily variation of temperature beyond the normal limit, and in the frequently recurring colicky pain associated with constipation, we have a most suggestive group of symptoms, sufficient if persistent in doubtful and progressive cases to justify, if not demand, an exploratory incision. If the tumor can be felt, the diagnosis is complete.

I think we should impress upon our students, and upon the profession upon every possible occasion, the extreme significance

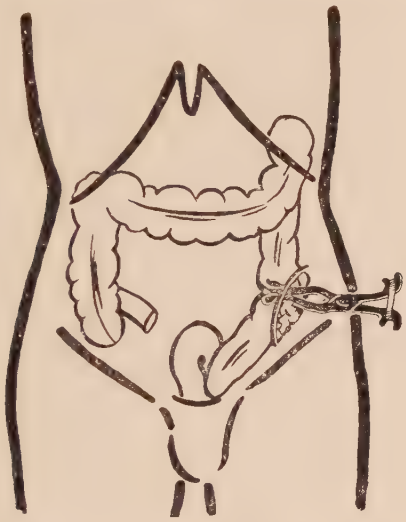

FIG. 1.—Lateral anastomosis by Mikulicz's kentrotribe.

of the three losses—weight, strength and color—occurring in people at or beyond middle life.

I do not propose to enter at all fully into the treatment of malignant disease of the cecum, colon and sigmoid, but upon one or two points, would like to express views which I have come to hold pretty strongly. First, as to the procedure to be adopted in the presence of acute intestinal obstruction, secondary to malignant disease. As well said by Barker in speaking of these cases: "The surgeon's judgment may be taxed even more severely than his skill, although both may be equal to many other emergencies."

These patients are often seen by the surgeon for the first time when the abdomen is considerably distended, vomiting present, the vomitus having a fecal odor, pulse rapid and of poor quality, evidences not only of obstruction but of toxæmia. The site and nature of the obstruction may be indeterminable except by exploratory incision. In these cases an incision in the median line below the navel is necessary to determine the seat of the disease. Under no circumstances should one be persuaded in these cases to do more than give relief to the immediate condition of toxemia, and empty the intestine of large quantities of septic matter, by an appendicostomy or an appropriately placed Paul tube. The resisting power of these patients is low; the toxemia is generally greater than is apparent, and their strength is as a rule overrated, with a subsequent surprise at their early collapse. In addition to a considerable degree of toxæmia, the bowel walls are often sodden, friable and more or less paralyzed. Operation here should be clearly restricted to the relief of the obstruction and drainage of the bowel above the obstruction. One should never allow his better judgment to be overruled by a desire to do a nice surgical operation. The next lesson that my experience has taught me is that a colotomy should be a last resource. It is a dirty operation, and particularly during the first few weeks, when done for acute obstruction, renders the patient more or less of a nuisance in the ward and a burden to himself, and furthermore, increases the danger of subsequently entering the abdomen to remove the growth. For the radical removal of the cause (a procedure of more than usual hazard after a colotomy, because of the difficulty of getting the abdominal wall thoroughly sterile) we have two alternatives, which I think should be adopted in all cases where the general condition of the patient and the condition of the intestinal walls permit. First I would place short-circuiting. This permits of the removal of the growth at the same time, if the condition of the patient justifies it. If not, the abdomen may be closed, and when the intestines have emptied, and the patient has recovered from the toxæmia, the growth may be removed at a second operation. This procedure is clean and safe.

Short-circuiting to be done with safety demands room to work and moderate intraintestinal tension. Mechanical obstruction and distention are not in themselves insuperable bars if the general condition is good and the walls of the intestines unaltered and in a condition to bear safe suturing. The distention may be overcome by withdrawing a convenient loop, and under proper safeguards emptying the bowels of a large part of their septic contents, aided if necessary by intestinal lavage. Stomach lavage, and intestinal lavage through an opening in a prominent loop, may render an otherwise difficult lateral anastomosis easy

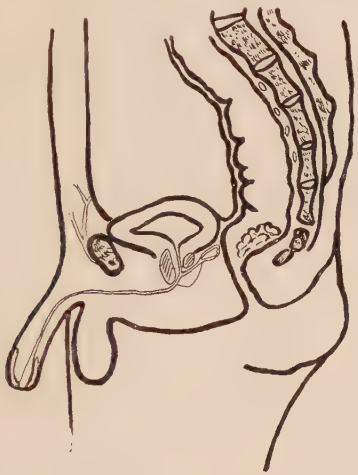

FIG. 2.—Showing the relative levels of the disease in high carcinoma of the rectum and the peritoneal pouch. The impossibility of thoroughly removing the disease without opening the peritoneum is apparent.

and safe. As a rule, stomach lavage materially improves the patient's condition. Exceptions to this rule occur occasionally. Just recently a man was admitted to my ward in the Montreal General Hospital, with a history that indicated that he had incomplete intestinal obstruction for three days, and complete for two. Stercoraceous vomiting for forty-eight hours. Rigidity and distention were present, and the pulse was weak and rapid. Stomach lavage, which was done immediately after anesthesia was induced, was followed by a condition of collapse. One of

my colleagues had a similar experience. Fortunately such instances are but rare exceptions to a very general rule.

If it is thought that the patient cannot bear even so long an operation as is required in a lateral anastomosis, or the intestinal walls are too sodden and friable for safe suturing, the growth may sometimes be delivered outside the abdominal wall and there anchored. A Paul tube can then be inserted into the proximal end on the proximal side of the growth, and the growth be removed later on. The intestinal canal can be subsequently restored by a lateral anastomosis, made by Mikulicz's kentrotribe. This proceeding may be regarded as safe, but is not ideal. It is open to the objection of a colotomy wound, and in the removal of the growth at a subsequent time, no opportunity is offered to remove the glands. Its rapidity and safety are its chief commendations.

The short-circuiting operation has been objected to by Bidwell and others on the ground that the second operation for the removal of the growth is rendered difficult by adhesions. This objection I do not think should have very great weight. The adhesions are often trivial, and generally easily separated. Two great advantages of this method are, that the patient is clean from the first, and that at the second operation one enters through a clean abdominal wall when the patient is thoroughly recovered and in good condition, and one then has an opportunity of removing the lymphatic glands, and thus giving very much greater freedom from recurrence. If, however, only a colotomy is possible, I believe the advantages of a Paul tube to be very considerable. It remains *in situ* six or seven days, during which time a very fair union takes place between the abdominal wall and the intestine, and with care no infection should occur between these surfaces.

When operating at a time of election for the removal of malignant growth, I should say that a colotomy should never be done except for a fixed irremovable growth in the pelvic colon. In the case of irremovable growth situated above the sigmoid an ileosigmoidostomy possesses every advantage; it is safe and should

be preferred to colotomy. It goes without saying that the canal should be restored in all cases, when possible, after the removal of the growth. The relative merits of an end-to-end or lateral anastomosis depends somewhat upon the situation of the disease. It may be said, however, that safety of end-to-end anastomosis obtains only in the transverse colon and sigmoid, which are generally completely surrounded by peritoneum.

Cancer of the rectum is more common than that of the sigmoid. Malignant disease is here only too often well advanced

FIG. 3.—Abdominoperineal method. The gut divided well above the disease, and the glands removed through the abdominal incision. The diseased area is then pushed down by blunt dissection. The pelvic opening closed by approximating peritoneal folds, and the abdomen also, after upper end of gut is brought through colostomy wound. Lower end then removed through perineum.

before its nature is discovered, and there would seem to be less cause for delay, because in nearly the whole of its extent it may be palpated with the examining finger. As elsewhere, there should be a method in examining the rectum, and in every case where the symptoms are sufficiently suspicious to justify an examination at all, the examination should not be considered complete until the whole of the upper part of the rectum is carefully and thoroughly palpated. I think it was Leube who first drew

attention to the association of piles and carcinoma of the rectum, and expressed the opinion that often the swelling of the hemorrhoidal veins was due to the carcinoma. Nothnagel elaborated this view somewhat, and states that suspicion of carcinoma of the rectum is very much more probable when constipation and hemorrhoids come on more or less suddenly in a person who was previously quite regular. The harmless form of hemorrhoids usually develops as a result of prolonged and persistent constipation. The extreme importance of a thorough examination of the whole length of the rectum in every case of hemorrhoids or rectal distress cannot be unduly emphasized.

The unsatisfactory results hitherto obtained in carcinoma of the rectum have been due primarily to tardiness in its recognition, and secondarily, to the method adopted in its treatment. Of the operative treatment of carcinoma of the ampulla, I will not speak, but shall confine my remarks to high carcinoma of the rectum, by which I mean carcinoma situated from 5 to 9 cm. or two to three and one-half inches above the anus. The mortality has so far been high and recurrence frequent. The disease should be removed with at least one inch of healthy gut above. One must be prepared to find the reflection of the peritoneum within two and one-half inches of the anus, opposite the first coccygeal vertebra. It follows, therefore, that high carcinoma of the rectum cannot be removed as it should be without opening the peritoneum. This is not, however, the whole problem. Freedom from recurrence here as elsewhere can only follow complete removal of the whole diseased area in its entirety, and with it the lymphatic glands within reasonable limits. I have for many years taught that the word recurrence is unfortunate. It is a term that covers a multitude of sins. It is a break-water behind which we are all glad at times to take refuge. The word that the operating surgeon should ever have in mind at the operating table is continuance. An operative method, to be not only efficient, but sufficient, should give access to at least the level of the fifth lumbar vertebra. Nothing less is sufficient for the removal of a malignant growth, the upper limit of which can just be reached

by the examining finger. I think that I can safely say, that the perineal route has been tried and found wanting.

Of the different methods of approach from behind, through the sacrum, one must speak guardedly. By this method I have had some fairly good results. In one case the proximal end of the gut was brought down and twisted as recommended by Gursuny. The patient left the hospital in good condition, and I have never been able to get track of him since. In one other, I brought the proximal end out between the lower fibers of the gluteus maximus muscle, as suggested by Witzl and Rydygier

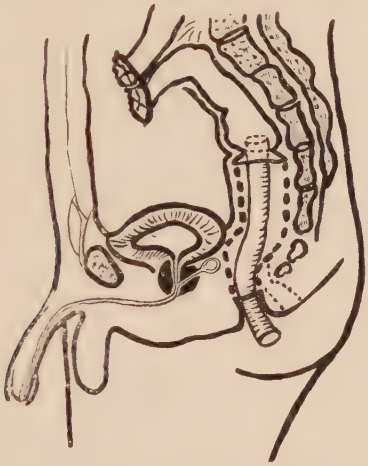

FIG. 4.—After excision of growth and glands. Upper end of bowel could not be brought to level of skin. Rubber drainage-tubes tied into upper end, to avoid infection until granulating surface had formed. Tubes came away on eighth day.

Two years later this man was well, had fair control and comparative comfort. In two cases I joined the ends, the upper to the lower. In both very careful preparation had been made. The bowels had been most thoroughly emptied daily for ten days. In one I had taken the additional precaution of doing a preliminary colotomy, yet in both leakage occurred, in one proving fatal from infection and sepsis occurring locally; the other made use of the colotomy wound permanently. Convalescence in both

cases was slow. It may be said of the sacral operations that they give good access and are comparatively bloodless. On the other hand they leave a large space difficult to protect from infection, and which, once infected, becomes a source from which septic absorption readily takes place and which is very slowly obliterated. Convalescence is prolonged, and sinuses and fistulæ may persist indefinitely.

I am satisfied that a combination of the abdominal and perineal methods gives promise of better results in high carcinoma of the rectum and pelvic colon than any other of which I have any experience. It may be occasionally that it is right to do as I did in a case recently operated upon. In making a preliminary examination, I could get well above the disease; it was not at all adherent in front, and was fairly movable behind, so much so, that I felt that I could bring the disease down and get well above it by the perineal route, and in this I succeeded. The mesorectum, however, was so thickened and indurated that I could not bring the proximal end down to the lower, nor could I bring it down without tension, to the level of the skin through the notch. I therefore opened the abdomen and did a left inguinal colotomy with a Paul tube. The colotomy wound was absolutely perfect; complete primary union all round, without a drop of pus. I attached a large rubber drainage tube to the proximal end in the pelvis, and brought it out through the anus. This kept the perineal wound clean until the tube came away on the eighth day, by which time the surface was more or less granulating and less absorbent. This patient has made an uninterrupted recovery; his temperature scarcely going above 99° and his pulse remaining about 80°. He was out of bed on the tenth day, eating and sleeping well the whole time. Of course, he has a permanent colotomy wound, but I think this is as well taken care of as one situated behind. The disease proved to be adenocarcinoma. The uppermost of the glands removed were not infiltrated. The gut between the colotomy wound and the point of division below remains permanently. This method can be carried out without exposing the peritoneum to infection.

When the growth is situated a little higher, opposite to the third or fourth sacral vertebra, two or three alternatives present themselves for consideration. In one instance, after I divided the gut an inch below the growth, there remained, after closing and infolding the lower end, about an inch on its anterior surface covered by peritoneum. This was too small a surface, especially situated as it was low down in the pelvis, to permit an anastomosis by suture, but I thought I could accomplish it with a Murphy button. Unfortunately, perhaps because of my clumsiness, the button in the lower segment slipped away before

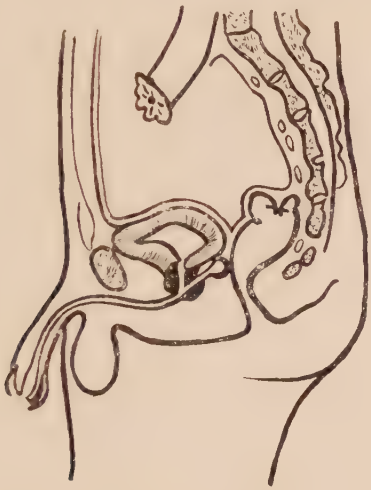

FIG. 5.—Diseased area excised. The lower end covered by peritoneum, too short for lateral anastomosis. It was infolded, covered by peritoneum, and upper end brought out through colostomy wound.

I had succeeded in locking the two parts together. I then closed the opening altogether, and brought the proximal end out through a colotomy wound. All went well for seven days, when symptoms of peritonitis developed, which ultimately proved fatal. The infection occurred I think from the end of the rectum left in the pelvis.

My next case was a female, and the disease, adenocarcinoma, was situated about opposite to the third sacral vertebra. Here

I removed the diseased area with one inch of healthy gut distal, and three inches proximal to the growth, together with all the glands that could be found, and then closed the lower end by infolding, and after pushing it down as far as possible, I closed the peritoneum over it with two rows of sutures. The proximal end of the gut was brought out in the left inguinal region, and a Paul tube attached. This left the peritoneal cavity all closed in and protected from infection. Convalescence here was retarded by infection occurring around the closed end of the pelvic rectum. It was localized and did not involve the peritoneum.

In my next case the disease was about the same level, *i. e.*, opposite to the fifth and fourth sacral vertebræ. After the growth with a very free margin, about four inches was removed, the peritoneum on the side and anterior surface of the rectum was divided, The pelvic end was closed, infolded, and by blunt dissection. carefully separated all round, and together with the vessels and glands situated posteriorly was pushed well down behind the bladder and covered with a pad of gauze. The peritoneum was closed over by suturing the plica semilunaris on one side to its fellow on the opposite side, and the two to the peritoneum behind. The edges of the peritoneum were brought together over the area exposed by the removal of the pelvic sigmoid. The proximal end of the gut was brought out through an opening in the left iliac region, and a Paul tube attached. This left the peritoneal cavity all closed and with a complete lining of peritoneum. The rectum was then removed by the perineal route. It is an advantage in these cases to leave the sphincter and anus. Convalescence here was ideal.

This combined method I believe to be safest, and followed by a smoother and more comfortable convalescence than any other that I have been able to carry out for disease at this level. It has this advantage (although I have never practised it), that if the patient's condition causes anxiety, the perineal part of the operation can be postponed for a few days. I may say, however, that the four patients upon whom I have operated by the combined method, have exhibited no evidence of shock. The un-

fortunate part is the permanent colotomy. This, it goes without saying, should be avoided when at all possible. So far as I have been able to judge, however, from watching a number of these people, I should say that a man with an inguinal colotomy is cleaner, more independent of nurse or valet, and altogether more comfortable than the man with the opening in the sacral region; that the abdominoperineal method has a lower mortality and a shorter convalescence than the sacral methods; that it affords

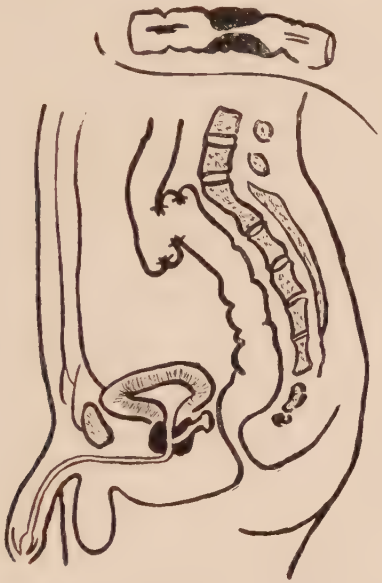

FIG. 6.—Intra-abdominal anastomosis between rectum and sigmoid, colon or ileum. Restoring the canal should be practised, where possible.

an opportunity to observe and deal with extension to the peritoneum or bladder, and that an end-to-end anastomosis of the pelvic rectum is impracticable. By the abdominal method, if there is sufficient length at the distal end of the bowel after safe closure and infolding (and what is sufficient length will depend somewhat upon the size of the patient, the skill of the operator and his surroundings), immediate restoration of the canal should be obtained by a sigmoidorectostomy or ileo-

sigmoidostomy or ileorectostomy. In a lateral anastomosis between two parts of the colon, I like a sew line of three inches or more, which gives me an effective opening of two and a quarter inches or two and one-half. Less would do, particularly if the ileum were joined to the pelvic colon.

CANCER OF THE SIGMOID AND RECTUM.

By C. H. MAYO, M.D.,
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With some modifications, the curability of cancer is generally accepted. To obtain the best results, it is essential: That the disease be confined to the structure of its origin and the immediate lymph nodes tributary to it. These conditions may be, to a great extent, changed by the type of the cancer and the age of the patient, cancer being, relatively, more rapidly disseminated in the young with their active lymphatics than in the aged with their natural vessel changes.

In considering cancer of the rectum and sigmoid, we find that three men are thus affected to one woman. With regard to the frequency, Herman's collection from the Prussian hospitals shows that, approximately, one-half of all cancers affect the alimentary tract, and one-sixth of these are in the large bowel. Ewald's collection of over eleven hundred cases gives their location as about nine in the rectum and two in the rest of the colon.

Cancer extends by continuity of tissue and through the lymph nodes, rarely by veins, especially portal, causing liver nodes and grafting on peritoneum. It may be said of the disease in general that the secondary or metastatic growths are the usual cause of death where tubular structures are not involved. It is now known that Nothnagel's estimate of the duration of life with cancer of the bowel, which he gave as from six to twenty-four months, is very often exceeded. Infection in some organs or regions rich in lymphatics, like the lung, neck, or axillary, early involves the glands, but the colon, with a reduced lymph supply, brought about

through ages of resistance to bacterial life, of which it is a natural harborer, often holds malignancy for a long time as a purely local disease.

The large bowel is the drier of the fluids delivered from the small intestine, where the bulk of the proteids are extracted. It is probable that Metchnohoff is too radical in his views concerning its elimination, overlooking its value as an absorber of water.

The lymph drainage of the anal portion of the bowel passes to the inguinal glands, while that of the lower rectal passes laterally in the region of the middle hemorrhoidal vessels. A few lymph channels are tributary to the pudic glands, while the greater portion gather above the levator ani muscle and pass up the midline with superior hemorrhoidal vessels to the prominence of the sacrum.

Hausman, in 112 collected autopsies of those dying of cancer of the bowel, found that 55 were limited to the bowel; of the remainder, but 36 involved the lymphatics, and 21 cases showed general infection. Such conditions would be expected to occur above the rectum, from the lymphatic condition.

Treves, in his report of 100 cases of stricture of the bowel, found 70 in the descending colon and sigmoid, 58 being in the latter situation.

We have, then, a disease in a removable structure which is slow to disseminate infection, and yet, approximately, only one-half of the cases are discovered at an operable period, as far as curability is concerned, being usually called external or internal piles if low. This is due to the lack of marked symptoms in the early period, to the carelessness of the patient, and often to the failure of the physician to examine, although he prescribes.

There is more excuse for delay in those cases occurring above the rectum; and here we must consider that attacks of obstruction of the large bowel occurring without inflammation in those beyond middle life are indicative of stricture, which is probably cancerous. Early symptoms of cancer may be relatively trivial, as diarrhœa, or alternating diarrhœa and constipation, passages of mucus and blood, and the presence of piles.

The usual type of malignancy here is adenoma carcinoma.

It begins in the mucous membrane, and later invades the muscular and peritoneal tissues. According to Ball, tumors felt outside the rectal wall, and not attached to the mucous membrane, are not cancer; tumors of the mucous membrane not attached to the muscular coat are adenomatous, and not as yet distinctly malignant.

In the most of cancer work there has been too little attention paid to the character of the cancer in basing the prognosis. This subject has received particular attention in the report of the surgical clinic at Heidelberg by Peterson and Colmers. They found that microscopically solid carcinomas return in every instance. The carcinoma adenomata they divided into simplex, papilliform, microcysticum and gelatinosa. The colloid form gave one hundred per cent. of recurrence, the simple adenoma carcinoma had an exceptional cure, while the microcystic and papilliferous remained well. All mixed forms, like the polypoid, recurred, the superficial ulcers usually being carcinomata adenomata, the simplex giving an occasional cure, while the deep circular ulcers with nodes have a poor prognosis from early dissemination.

When cancer involves the sigmoid, a large majority of cases will require an exploratory incision to determine the exact nature of the affection as well as its location. If cancer, the question at once will arise as to whether or not it is possible to extirpate the growth. The removal will be decided by the extent of the invasion of the lymphatics, adjacent structures, or liver, also the age and general condition of the patient.

When possible, the diseased area is removed and some form of immediate anastomosis performed, usually suture, either with or without colostomy, which may often be necessary to relieve temporarily the oftentimes enormously distended and impacted condition of the intestines above the disease. It frequently becomes necessary, immediately after opening the abdomen, to relieve the gas or fluid distention by puncture of the bowel with a trocar.

In removal of sections of the colon, we can place considerable dependence upon the integrity of the blood supply, which resembles in this respect the tolerance of the stomach, so that suture anas-

tomosis is made in an increasing number of instances. Where it cannot for various reasons be employed, and it is desired to obtain the temporary advantage of a colostomy with a later closure of this opening, it is accomplished in the following manner. (Mikulicz.) The open ends of the bowel are sutured together for two-thirds of their circumference, exactly like an end-to-end anastomosis, the opposing sides of the bowel being also sutured together for four or five inches. A small abdominal opening is now made at a favorable point, and the bowel union drawn into this incision and secured by sutures, the larger abdominal incision being closed. A couple of weeks later a pair of large forceps are passed into the artificial anus, one blade into each portion of the bowel, and clamped together. The clamps are tightened each day for four or five days until they cut their way through and re-establish the lumen of the proximal and distal portions of the bowel. There is no danger of clamping the small intestine; the large bowel having been sutured laterally prevents their passing between the clamped portion of the bowel. The external fistulæ can be closed at any time, thus practically making an intra-abdominal intestinal anastomosis without an incision. We have employed this method four times, with a perfect result. The same result can be obtained by joining the distal end to the side of the proximal bowel, the end of the latter being brought out of the abdomen for a temporary safety colostomy.

In case the tumor is not removable, the diseased area can be short-circuited by uniting the bowel above and below the obstruction. If the bowel is empty, suture anastomosis is employed, or the McGraw ligature. Especially is the latter useful in cases with an excess of free peritoneal fluid and where the tumor is not removable, although extensive operation in such cases is a questionable procedure in most instances, as the reparative powers of the peritoneum are so reduced. The anus is thoroughly dilated at the close of all methods of operation, and a gas-tube inserted into the rectum.

Certain definite results are desired in operations upon cancer of the rectum, namely, permanent cure, low operative mortality,

and a controllable anus or its best substitute. Cancers of the rectum can be clinically divided into two main groups: (1) Those within easy reach of the finger, not exceeding from two to two and a half inches in distance from the anus. (2) That larger group which lies above the levator ani muscle and can be reached digitally with more or less difficulty.

The first group can be disposed of in a few words. The lower end of the rectum, with the growth, can be dissected out through the perineum, aided by an incision backward, and removal of the coccyx, if necessary. This incision is usually sufficient, but may be extended by continuing it upward along the side of the sacrum until ample space is secured. Occasionally an operation started in from the perineum develops unsuspected glandular metastasis at a higher level, justifying a Kraske operation, the fourth and fifth sacral vertebræ being removed to give additional room.

In the female, this anterior route may be chosen instead, and by a free incision through the posterior wall of the vagina, operating space may be obtained. (Murphy, Byford.) In either method the hemorrhage may be readily controlled, as it is almost entirely from small branches of the internal pudic and coccygeal arteries and from inferior hemorrhoidal plexus.

The results for low rectal cancer are essentially unsatisfactory, particularly in the male, on account of the urethra, prostrate, and neck of the bladder. As the entire muscular apparatus of the rectum is removed, control is not to be expected. Therefore extensive dissections for the purpose of drawing the rectum down to the anal margin are not of great value.

The skin around the anus can often be mobilized sufficiently to reach up to the rectal stump. This can be facilitated by lateral incisions and by undermining the skin, securing in this way two flaps attached at each end, which can be slid up into the space.

Surprising to relate, many patients retain very fair control, as the sigmoid, which is the natural fecal container, has not been interfered with, and unless the stool is loose, involuntary escape may not be sufficiently frequent to be a source of great discomfort.

In some individuals the rectum will retract, leaving a considerable extent of scar tissue. This is funnel-shaped toward the outer side, and usually does not give rise to annoying stricture. Occasional wearing of a rectal plug overnight produces the required patency.

If the prostrate is involved to any extent, more extensive operations are needed, and as the region can be better seen, by the posterior incision or Kraske operation, this route, in cancers which lie two inches above and yet entirely within reach of the finger, is the most satisfactory, although it will be necessary to open up the peritoneal cavity and loosen the bowel until the upper fragment can be approximated to the anal margin.

We believe the foregoing covers the clinical usefulness of the lower posterior operation. The mortality is from 5 to 10 per cent., and permanent cures are to be expected only after early operations. Unfortunately, the disease is usually supposed to be piles until too late for cure. We have had a very few satisfactory results, but the majority had a speedy return.

The second group is by far the larger, comprising as it does all of those cases which lie above *easy* reach (two to two and one-half inches) of the examining finger.

In the case of the lower route, the arguments in favor of some form of posterior or Kraske operation for high rectal cancer are numerous. It brings the operator down at once upon the region of disease. If the lower end of the rectum, including the levator ani muscle, as well as the internal and external sphincters, is not involved, the upper fragment, by loosening the lower sigmoid, can be drawn down and directly sutured to the distal end; or if only the external sphincter is saved, after excision of the mucous membrane the upper fragment can be drawn down and united to the anal verge.

The disadvantages of this method are many. The operation is a bloody one, much of the hemorrhage being difficult to control except by hot gauze packing. Inspection of the operating field is not ample and clear, especially at the upper part. In particular, one cannot make that high removal of lymphatic glands and

possibly infected fat which we have learned is the most important safeguard against metastasis.

As a matter of experience, it is shown that a direct end-to-end union is by no means a satisfactory procedure, even providing it can be done. The lower fragment, having no peritoneum, does not unite readily, and the upper end, being invested with peritoneum only on its anterior and outer aspects, does not furnish sufficient of this structure to safeguard plastic union. It is true that the peritoneum can sometimes be loosened and sutured around the upper portion, giving it a complete peritoneal investment. But the rule is, that union is not complete, and small but intractable fistula at some point results. Generally, the muscular apparatus of the rectum is necessarily so badly damaged in the removal of the disease that even if the bowel can be drawn down to the anal margin, muscular control will be incomplete and unsatisfactory.

The operation for hemorrhoids known as the American (Whitehead), a simple procedure as compared with this, frequently causes either stricture or incontinence.

In many cases the bowel cannot be drawn down, necessitating a sacral anus, which is exceedingly unfortunate, as the situation is one which is inaccessible to the patient, rendering cleanliness difficult. If it is necessary to pull the bowel down to any great extent, the sigmoid loop as a fecal container is destroyed, and frequent and uncontrollable stools the rule.

The operator may hesitate to remove resolutely, regardless of consequences, all of the tissues which may be infected, but which lie outside of the directly involved area, as he has in mind continually the desirability of giving future continuity of function. Lastly, the surgeon is unable to judge of the limits of the disease above until the operation is nearly completed, and many a victim of cancer of the rectum is subjected to an unavailing and mutilating procedure which would not have been undertaken could the operator have known beforehand of the extent of involvement.

Attempts to obviate some of the disadvantages of the sacral operation have been made, especially as to securing a larger field

by osteoplastic resections. The best of this class is the one in which a quadrangular flap, with its base at the anus, is made by lateral incisions extending up to the fourth sacral vertebra, the fourth and fifth sacral vertebra being separated from the sacrum with a chisel and the trap-door turned downward.

Osteoplastic resections interfere with free drainage, and removal of the bone is not difficult nor does its retention add anything to function.

The mortality after the sacral operation has been considerable, largely due to infection, on account of the difficulty of securing and maintaining freedom from fecal contaminations.

We have followed the advice of Hochenegg in carefully clearing out the bowels two days in advance of the operation, and allowing at least twenty-four hours to elapse for the stools to become formed before operating.

In order to avoid infection from the common source, it has been the custom of some surgeons to do a preliminary colostomy for the purpose of diverting the fecal current, to be followed by the radical operation after an interval of from ten to fourteen days. This abdominal incision can also be utilized for the purpose of exploring the upper limits of the growth and the glandular involvement before making the fixation of the sigmoid.

The disadvantage lies in the fact that if the mesentery of the sigmoid is short, attachment to the abdominal wall may entirely prevent drawing the bowel down to fill the gap left by the resection, and the abdominal section must be unnecessarily large, as an exploration is inadequate without the introduction of the entire hand into the peritoneal cavity.

Permanent colostomy without removal of the growth has not sustained its reputation of ten years ago. It has few advocates, unless actual obstruction is imminent. As McBurney points out, obstruction from a low growth, unless of the annular variety, is better treated by curettement than by colostomy, and especially cauliflower growths, which seldom redevelop in such a way as to interfere seriously with the fecal current after thorough scraping out.

It must never be forgotten that after colostomy the period of disability has commenced, and as cancer of the rectum is often a slow disease, every effort should be made to delay the time of "waiting for death."

What results may be expected from the sacral operation? Hartwell, in a series of forty-six cases by sixteen New York surgeons, showed a mortality of 26 per cent., and only 16 per cent. living beyond the three-year limit; certainly, a poor showing when one considers the disability which attends upon the majority of those who do not die from the immediate effects of the operation. Our results after this operation have been about as Hartwell reports.

Quenu, in 1897, recommended a combined abdominal and perineal attack upon rectal cancer, and the operation which he advocated, modified to a greater or less extent, has had an increasing number of advocates, notably Weir, Abbe, and Tuttle in this country.

In common with the majority of surgeons, we have become dissatisfied with the sacral route, excepting in selected cases, and for five years have practised a modified Quenu operation upon patients who would consent to it. For sentimental reasons a large number of individuals elect the posterior operation even after careful explanation.

The Operation of Choice for High Rectal Cancer. Bearing in mind that the lymphatics of the lower rectum first pass laterally with the middle hemorrhoidal vessels and then converge posteriorly in the mesorectum with the superior rectal artery, it is evident that any operation, to be effective, must remove the entire chain of glands with all the fat as high as the promontory of the sacrum.

The method of procedure is as follows: The patient is placed in the high Trendelenburg position and the abdomen freely opened in the middle line. The upper limits of the growth and its relation to the surrounding tissues noted. The possibility of the removal of all of the obviously infected glands is ascertained, and the liver examined for embolic carcinoma. If the case is a favorable one, the intestines, with the exception of the sigmoid, are

carefully packed away with large gauze pads; two clamps are caught across the lower sigmoid on a level with the promontory of the sacrum and the bowel divided between. The mesosigmoid is liberated by lateral incisions and the proximal fragment brought up outside of the abdominal wound. A ligature is thrown around the bowel immediately below the forceps, which are removed as the ligature is drawn tight. A purse-string suture is placed an inch below the end of the stump, which is invaginated in a manner similar to that of the appendix. The ends of the ligature are left long. The threads and stump are carefully cleansed. The distal stump is treated by inversion in a similar manner to prevent soiling. Lateral and anterior peritoneal incisions are now made, liberating the rectum from the bladder and prostrate in the male and from the uterus in the female. The inferior mesenteric artery, which is the upper continuation of the superior rectal, is caught and tied above and to the left of the promontory of the sacrum at as high a point as can be safely done without interfering with the nutrition of the bowel used in the colostomy. The fat is carefully separated, the entire mass of gland-bearing fascia, with the fat, is wiped perfectly clean to the periosteum. The middle sacral artery is of considerable size in most cases, and should be caught and ligated near its origin from the abdominal aorta between the common iliac vessels. The dissection is continued downward, exposing the internal iliac vessels and the ureters. Most of this can be done by sponging. The middle hemorrhoidal vessels are caught laterally as they come off with the inferior. The entire area is now packed with hot moist gauze, and the patient put in the perineal position. In some cases, if the bowel is healthy, for a space of four inches above the anus, it is clamped and ligated at this point, and cut above the ligatures, the diseased area being removed. The operator, or preferably a second operator, begins the lower part. A pair of forceps are passed into the blind pocket of bowel from below, the tied end of the bowel is pushed into the open forceps, and they are withdrawn through the anus, inverting the bowel.

After cleansing, the thread of closure is cut, and the forceps are now passed through the invaginated bowel and anus into the

pelvis to grasp the proximal end of bowel, which is withdrawn, and the two ends united by a circular end-to-end closure outside the anus and allowed to retract. Drainage is secured by a midline incision in front of the coccyx, through which tube drainage into the pelvis is made. This type of operation (Mansill) we were able to make in four cases. In some colostomies, the lower end of the rectum can be saved as a blind pouch, or temporarily employed for drainage of the pelvis. Should the disease require such extensive removal of the rectum as to destroy the lower rectal wall muscles and nerves, as well as straighten the sigmoid loop, thereby losing retention and control, it is preferable to save the sigmoid loop as such and make an abdominal anus. To employ this method, a small gridiron incision is made on the left side, as would be done on the opposite side for appendicitis, and through this opening, using the ends of the threads as a tractor, the proximal stump is pulled out three-fourths of an inch beyond the skin surface. Three or four linen sutures are quickly placed, uniting the bowel to the peritoneum on the inner side, and a silkworm-gut suture on the outside closes each angle of the wound, including in its bite the skin, aponeurosis of the external oblique, and the wall of the bowel, holding it securely in position. If this plan is followed, the operator from below, after inserting the gauze in the rectum to facilitate subsequent dissection, and closing the anus by a circular suture, circumscribes the anal margin with a deep incision, and dissects the perineal portion of the rectum with its muscles and fat free from the prostate and urethra, or from the vagina in women. This extends up to the levator ani muscle, which forms the boundary between the upper and lower dissections. The abdominal operator now passes down the fragment of the lower sigmoid and the upper end of the rectum with its fat and glands into the perineal opening, where they are removed by the surgeon working below, or one operator, with changes of gloves, can accomplish the work in both fields. All bleeding-points are caught and ligated. A considerable-sized gauze drain is passed from above downward, leaving its upper end just exposed on a level with the peritoneum, which is drawn together to cover as much as possible,

the external gauze portion being brought out of the perineal wound. The sigmoid loop from above is placed over the exposed surface, and in the female the body of the uterus and broad ligaments are adjusted with a few sutures to aid in covering. The upper incision is completely closed, while the perineal opening is narrowed to proper dimensions for drainage by a few sutures.

The end of the sigmoid is left completely obstructed for the first twenty-four hours, after which time the circular suture, which is tied around it, is cut and the bowel opened.

The advantages of the operation herein outlined are obvious. The disease is removed widely, with all of its tributary lymphatics, muscles, and related tissue. The anus is placed in a position easy of inspection and cleansing; the sigmoid trap obviates the necessity of frequent stools, and the intermuscular incision gives a fair degree of control.

What may be expected from this combined operation?

In five years, W. J. Mayo and I, usually working together, have operated upon 26 patients, of whom 7 died as a result of the operation or within the first month. Of the 17 who recovered, 2 were not traced, but were known to be alive and well more than one year.

10 cases operated upon too recently to be of value are alive and well now.

1 operated upon a year ago died before the end of the year. This is the only one of those operated upon more than a year ago, and who survived the operation, who failed to live one year.

7 lived over one year; 5 alive now.

5 lived over two years; 3 alive now.

3 lived over three years; 2 alive now.

As there were only 4 of those operated upon more than three years who survived the operation, and 2 are alive and well, we have 50 per cent. alive and well over three years—too few from which to draw conclusions, but suggestive.

THE SURGERY OF TUBERCULOSIS OF THE COLON.

By L. L. McARTHUR, M.D.,
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Believing that my experiences with tuberculosis of the intestines sustain them, I submit the following propositions:

1. Intestinal tuberculosis is far more frequent than has been, in the past, accepted.

2. Its primary nature in this situation is now admitted to be 5 per cent. by the pathologists, who also claim that 25 per cent. of all human tuberculosis gains its entrance through the intestinal mucosa.

3. Either the "ulcerative" or the "hypertrophic" type of this disease is (at some time) amenable to surgical interference.

4. That interference should be either by excision or exclusion.

5. That surgical insult in these forms of intestinal disease is better borne than a like degree in any other.

6. That early recognition by the internist and interference by the surgeon would eliminate a large proportion of cases now classified as "tabes mesenterica."

The reopening of the question of the "infectivity of the bovine tubercle bacillus," in 1901, by Koch, in his London address, has done much to make clear the true status of intestinal tuberculosis, while demonstrating the fact that the bovine organism, though less virulent for man than heretofore held, does nevertheless occasionally induce *primary* intestinal disease.[1] Moreover, the careful

[1] Furst, in his most painstaking review of the question of tuberculosis (made necessary by the doubt thrown on the existing teachings by Koch's denial of the identity and dangers of the bovine tubercle bacillus), demonstrated that the number of cases of *primary* intestinal infection was much larger than had been heretofore believed, by collecting the histories of one hundred and sixty cases undoubted and well authenticated. Many of these cases collected by Furst were shown to be in all probability due to the bovine organism. Such authorities as Orth, Ganghofner, Baginsky, Demme, Kossel, Klemperer, Lubarsch, were quoted in substantiation of these claims.

review of the older statistics, and the more exact investigations by the pathologists of the more recent material, have determined quite a revulsion of opinion, both as to the location of the atria through which systemic infection occurs and the relative frequency of the same. Until recently we have been content to believe that the vast majority of cases of human tuberculosis occur through the respiratory tract. At present, based on statistics that have been obtained since those newer refinements of pathology, bacteriology, inoculation, and the microscope, were available, we are driven to the conclusion that the intestinal atrium is far more frequent than we have in the past accepted;[1] that nearly 50 per cent. of all autopsied children dying before the age of ten had the disease; and that the atrium is through the intestinal wall in over 21.2 per cent. and primary in 4.9 per cent. (Lubarsch). The relative proportion between the respiratory and intestinal tract is shown in the following table:

	Respiratory.	Alimentary.
Carr	75.2 per cent.	19 per cent.
Kossel	59 "	4.5 "
Hof	56.2 "	25.1 "
Still	55.9 "	25.5 "
Nebelthau	34.6 "	19.2 "

Some authorities even go so far as to say that *the majority* of all cases of tuberculous infection take place through this route (Brandenburg).

Since Eisenhardt found 56.3 per cent. of all consumptives, as determined by 1000 postmortem examinations, to have intestinal tuberculosis; since the latest reports show a fair percentage (5 per cent.) of *primary* intestinal tuberculosis among children,

[1] Villemin and Klebs in the earlier days, Dobroklowsky, Tschitovitch, Baumgarten, Behrens, Furst, and Horbitz in more recent times, have convincingly demonstrated that the bacillus may pass through the intact mucosa, to be arrested in the lymphatics of the mesentery, where they may remain months, years, decenniums, without giving rise to general manifestations. It is due to this latency that so many cases of primary intestinal invasion have been overlooked.

Horbitz, utilizing cultural and inoculation experiments in connection with his postmortem findings, has proven by these newer methods a far greater frequency than had been accepted; his data showing 22 per cent. for the intestinal route.

and since we are now observing implantation tuberculosis occurring on such inflammatory fields as occur in appendicitis, gall-bladder perforation, and stomach ulcer, this subject takes on an added interest to the surgeon.

Tuberculosis manifests itself in the intestine in two forms—the "ulcerative" and the "hypertrophic"—a description of which is deemed unnecessary.

It will always be a surprise that individuals extremely prostrated with this affection are yet so tolerant of such extensive surgical insults. Insults that in other ailments requiring similar surgical procedures prove fatal, in this bid us hope for still greater successes.

Both of these varieties, in my experience, are amenable, at times, to surgery. The nature of the interference must be determined by the individual case. So many factors will take part in its determination that no set rule can be laid down.

Practically, its surgery divides itself into either *exclusion* or *excision*, the choice being determined by the conditions obtaining in the given case.

The exclusion may be partial or total.

Excision, generally speaking, is more applicable to the hypertrophic variety and those cases of the ulcerative type in which the condition of the patient and the area involved do not too strongly militate against it; while *exclusion* is reserved for those cases in whom the extent of the ulcerative area involved or the extreme debility of the patient makes this simpler procedure appear the more advisable.

The term "partial" as here used is applied to a side-to-side anastomosis of the intestinal tube above and below the diseased area, while a "total" exclusion implies a resection of the bowel wall above the disease, closure of the distal end, with implantation of the proximal end well below the diseased area.

It is distinctly to be understood that *absolute occlusion* is never practised.

Though the number of cases of tuberculosis of the large intestine demanding surgical interference in my practice has been limited,

yet the regularity with which these cases have recovered has made me most hopeful for the future.

I present from my records cases upon which I have been called to operate illustrating the points I have desired to emphasize in this communication.

Of the hypertrophic type I have had four—two in the ileocecal region, one at the hepatic flexure, and one at the transverse colon; of the ulcerative variety, four.

Brief abstracts follow, with the treatment decided on and the points of interest. Of these case histories I select one each for illustration of the surgical points:

CASE I.—G., adult, male, aged forty years, merchant; general health, fair; hoarse for years; suddenly at night seized with severe abdominal pains that simulated, to the family physician, acute appendicitis, who ordered him to hospital. When seen a movable tumor could be palpated by bimanual examination; slight temperature; no leukocytosis; peristalsis visible.

Diagnosis. Tumor of ileocecal region with obstruction. Operation revealed an hypertrophic tuberculosis of the ileocecal valve. Resection of ileum, and ascending colon, with end-to-side implantation of ileum in ascending colon; resulted in prompt recovery. The hoarseness was later demonstrated to be a chronic tuberculous laryngitis.

This case, then, illustrates (1) the fact that "the source of infective elements is not necessarily from a pulmonary cavity;" (2) that the first sign of its existence may only become manifest when the compensatory hypertrophy of the bowel above the obstruction ceases to be sufficient; and (3) it is an example of the situation where, better than anywhere else, the Murphy button does its most efficient work—an end-to-side anastomosis of the small with the large intestine.

CASE II.—O. Y., adult, aged sixty years, plethoric, merchant; had enjoyed fair health till last ten years of life. In that time suffered from cholecystitis with jaundice (from stone), was diabetic, and had had pulmonary hemorrhages, for which he had been sent to California. While there was seen by Dr. J. B. Murphy

for a severe cholecystitis with—as later evidences showed—perforation of gall-bladder into colon. On convalescing from this attack, a sensitive gall-bladder region with tumor remained. The family physician, Dr. Frank Billings, kept him under treatment until pulmonary cavity had healed, diabetes had practically disappeared and condition seemed to warrant the interference deemed necessary for the supposed diseased gall-bladder with stones, causing progressive intestinal obstructive symptoms. Incision over the tumor came upon a cartilaginous-like hardness of the abdominal wall, involving the internal and external obliques and transversalis, in the form of a plaque three inches in diameter and half an inch thick. After entering the abdominal cavity it was possible to determine the tumor to be an hypertrophic tuberculosis of the hepatic flexure of the colon with stenosis. At this point the gall-bladder had drained. No stones to be palpated in the gall-bladder.

Treatment. Resection of ileum ten inches from the cecal valve; implantation of proximal end in transverse colon by button; closure of distal end. Prompt recovery, with restoration to health and disappearance of tumor until almost impalpable.

Here in a plethoric, tuberculous diabetic, operated upon for chronic gall-bladder disease, it seemed wisest to be content with exclusion of that portion of the intestinal tract involved.

This case illustrates most convincingly: (1) How a secondary implantation of a tuberculous process may be engrafted on a simple inflammatory one below; (2) how, when the tuberculous process lies in contact with the parietal wall, those indurated areas described by Vocht, and since observed by Tillman and others, develop by a fibrosis similar in character to the hypertrophic changes induced by the same organism in the bowel wall; (3) how the mere diversion of the fecal current will often relieve the active process, and finally, how the most unpropitious outlook of diabetes, tuberculosis, and gall-bladder disease in an old and plethoric individual need not necessarily contraindicate even a section of the bowel with diversion of the fecal stream.

CASE III.—H., adult, male, aged forty years, schoolteacher; had always enjoyed fair health; had acute appendicitis, for which he was operated in a neighboring city, appendix being removed. Fecal fistula followed. He was reopened after eight weeks and perforation in bowel closed. This failing, two months later he was brought to the writer. Examination of curettings of the granulations lining the sinus revealed tuberculosis. Patient was prepared for intestinal resection if found necessary. At operation several small openings in cecum found. Enlarging same, revealed tuberculous ulcers throughout cecum and ascending colon. Patient being in otherwise good condition resection was determined on. Ileum resected three inches from valve, and colon ascendens half-way to hepatic flexure. Before inverting colon end, for closure, it was inspected to see if area in beyond were healthy. Finding ulcers still very numerous, removed hepatic flexure and one-half the transverse colon. Closure of end of colon, end-to-side implantation, by button, of ileum. Recovery, with slight fistula until a silk suture was discharged. Patient gained immediately in health and returned to superintendency of school in Colorado, where he has continued in good health.

This case seems to illustrate (1) the type of intestinal tuberculosis for which Benoit has proposed the term "appendicitique," so closely may it simulate that disease; while for the other he suggests the term "neoplastique;" (2) that the removal of the major portion of the diseased area may result in a cure; (3) that the removal may at times require extensive resection of both small and large intestines.

No cavity found in lungs at time of operation.

CASE IV.—T., young, healthy man, aged twenty years; while visiting the World's Fair in 1893 was seized with such severe abdominal pains that he had to be removed to the emergency hospital on the grounds. Here his perforated appendix was removed by Dr. John E. Owens, and the infected area drained. A fecal fistula followed, which failed of cure by Dr. Owens at a secondary operation. With change of service case was transferred to me. In making the third operation to close the distressing fecal fistula, I

found several perforations of the caput coli that were evidently tuberculous. Enlargement of them for inspection of interior of cecum revealed several other ulcers, so excision was made of ileocecal region with enlarged lymphatics at ileocecal junction. End-to-side implantation of ileum into ascending colon (button); recovery. Two years later I learned of his death in the woods of Minnesota, whither he had gone for a pulmonary tuberculosis which was not discovered, if existing, at the time of his operation.

I am of the opinion that this was a case of implantation tuberculosis on an inflammatory area in the stump of an acute appendicitis either from the food or milk, with subsequent spreading to the lungs, as has been demonstrated by Baumgarten, Behring, and others to occur when the primary focus is in the intestines, and is in consonance with the most recent expert pathological findings.

Case V.—A robust child of ten years; had such a mild acute appendicitis as, in the opinion of Drs. A. D. Bevan, Frank Cary and L. E. Frankenthal, to not require operation. All the classical symptoms, with small tumor formation on second day in cecal region. Subsidence of the febrile movement at the end of ten days, but some persistence of the induration. After six months in the country patient was examined by Dr. Christian Fenger, who offered the opinion that the persisting tumor was a granuloma. Child did not thrive, tumor increased in size; there were nodes to be felt in the mesentery, evening rise of temperature, loss of appetite, and progressive emaciation. Diagnosis ultimately made of an abdominal tuberculosis by Drs. Bevan and Billings. With the intestinal obstructive symptoms growing worse, laparotomy by Dr. Bevan demonstrated general tuberculosis of peritoneum (with the nodes of bovine tuberculosis), omentum, intestines, mesenteric glands, and hypertrophic stenosis of the ileocecal region. Conditions did not seem to warrant anastomosis so abdomen was closed. Patient left hospital in two weeks. Consultants advised: (1) *X*-ray; (2) change of climate; (3) absolute rest. These were carried out simultaneously at El Paso,

Texas, with distinct improvement of all except the obstructive symptoms. These growing progressively worse became total in nine months and made it absolutely imperative to reopen for anastomosis. This I did. On reopening, *the only evidence remaining* of the former tuberculosis was an hypertrophic tumor of the ileocecal region. Ileum enormously dilated; descending colon atrophic; peritoneum smooth. Side-to-side anastomosis of ileum with sigmoid. Relief of the obstructive symptoms, with prompt recovery of the patient. A restoration to health by the gain of a pound a day for the first thirty days, after which a steady increase in size and weight.

The points in this case are: (1) The implantation of a tuberculosis on a mildly inflamed appendix, perhaps from the milk of a tuberculous cow, on the later investigation thought to exist in the herd of cattle, the source of her milk while in the country; (2) the complete subsidence of the same under the systematic combined use of laparotomy, rest, *x*-ray, and change of climate, leaving behind the fibrous stenosis of the ileocecal valve, for which (3) lateral anastomosis of the ileum and sigmoid proved a perfect relief, by exclusion of the entire colon; (4) that here the entire course of an abdominal tuberculosis which had been watched throughout all its stages, both clinically and by operation, encourages the hope that the time may yet come when operative interference for abdominal tuberculosis will be made before it has advanced to a tabes mesenterica; but even then the case may not be hopeless, especially if we can eliminate by our interference the infective focus.

MYOFIBROMA OF THE LARGE INTESTINE.

By W. L. ESTES,
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True myofibroma, that is to say tumors which may be classed strictly as (1) leiomyomata or (2) rhabdomyomata of the large intestine are practically unknown. Tumors involving the large intestine are usually fibromyomata, and the muscular elements they contain put them, with very rare exceptions, under the class leiomyofibromata. These tumors are found most frequently about the rectum. A few cases on record have affected the colon and cecum. The sigmoid flexure is very rarely involved.

The literature of myomata of the large intestine is very meagre. E. Lexer (*Verhand. d. deutsch. Gesellsch. f. Chirurg.*, Berlin, xxi, part 2, pp. 440–446) gives the best summary of cases and discussion of the subject I have seen. He divides myomata of the large intestine into three groups, as follows:

Group A. Tumors which develop in the lumen of the gut. These tumors appear as roundish or polyp-like tumors; they are pedunculated, covered by mucous membrane and are of rather a hard consistency. These are found usually in the rectum; microscopically they are fibromyomata. They may usually be removed by the way of the anus by ligating and cutting through the pedicle. Lexer collected six cases of this variety. One reported each by Tedenal, Carlein, and Heurtaux; two reported by König and one by Caro.

Group B. Tumors which develop from the outside walls of the intestine, also more or less pedunculated. These impinge on the lumen of the intestines by pressure, on account of their bulk;

they involve usually the upper part of the rectum or lower sigmoid. They must be removed by a laparotomy. Three cases are given under this group—namely, one each by Senn, Westermark, and Pfannenstiel, the latter a double tumor.

Group C. Tumors which develop from the rear of the rectum, which by their growth fill up the cavity of the pelvis. They must be removed by sacral exsections or parasacral incisions. Three cases are given under this group—one each by Berg, McCosh, Lexer.

The tumors of the last two groups are difficult to diagnosticate, and are usually mistaken for other growths.

Lexer credits Longuet ("Des tumeurs Conjonctions benign du rectum," *Le Progrès Medicale*, 1898, S. 137) with the collection of six of these cases.

I have been able to collect a few other cases, reference to which will be found in the short bibliographical list appended to this paper.

These tumors are the true fibromyomata of the large intestine.

I have a case to relate which suggests the possibility of a fourth group—namely, inflammatory or hyperplastic myofibromata. While there can be no doubt that the tumor in my case was of inflammatory origin, it was a distinct circumscribed ovoid mass, uniform in development, symmetrical in shape, which produced by its growth and mass almost complete obstruction at its immediate location, and especially it was made up chiefly of muscular tissue with fibrous deposits, and it was pronounced histologically a myofibroma. It was more than a hyperplasia. It was a tumor made up of mixed elements, but chiefly of myofibromatous tissues.

Obstructions of the large intestine by strictures which result from chronic inflammations not involving the mucous membrane are very rare, but there are several cases on record of this kind. I will mention these later on.

R. Willmanns (*Beiträge zu klinische Chirurgie*, Tübingen, 1905, xlvi. 221–232) published under the title "Ein Fall von Darmstenose infolge Chronisch entzündlicher Verdickung des

Ileocecal Klappe" a case of obstruction of the bowels on account of the thickening of the muscular layers at the ileocecal valve. Rotter, whom I will quote presently, gives some cases of inflammatory strictures which involved the sigmoid. None of these cases, however, presented a distinct circumscribed mass which, without involving the mucous membrane, produced by its bulk and pressure nearly a complete obstruction of the bowels. My case seems, therefore, unique. The history of the case is as follows:

T. M. D., aged sixty-two years, married, American; entered St. Luke's Hospital, November 10, 1904. His family history was unimportant. He had never been a robust man, but he had enjoyed fairly good health up to about seven years before this time. At this period, namely, seven years before he entered the hospital, he consulted me about some dyspeptic symptoms and obstinate constipation. Notwithstanding treatment his constipation became worse, and a tumor gradually developed in the left iliac region. This tumor was quite hard, slightly nodular and seemed to be located between the sigmoid flexure and the left sacroiliac synchondrosis; it was firmly fixed, not particularly sensitive to the touch, and seemed to be connected to the pelvic fascia rather than to the gut. Gradually fever and almost complete obstruction of the bowels developed. The tumor steadily increased in size without losing any of its hardness. Dr. John C. Da Costa, Sr., of Philadelphia, saw the case twice in consultation and concurred in the diagnosis of a hard tumor of the pelvis, which caused occlusion of the intestine by pressure upon the walls. I thought the tumor was a sarcoma which originated from the neighborhood of the left sacroiliac synchondrosis. Dr. Da Costa expressed no opinion as to the nature of the tumor but agreed with me that it did not involve the lumen of the gut except by juxtaposition. Septicemic symptoms finally came on, then a very large swelling which involved nearly the whole left iliac region developed; this soon became cystic and adhered to the anterior abdominal walls. These evident manifestations of pus were speedily met by an incision below and about 3 cm. within the anterior iliac spine. A large quantity of most offensive pus and

blood was discharged. A drain was introduced and daily washings out were instituted. Improvement began at once and the patient made a slow but apparently complete recovery, first from the septicemia, then from the intestinal obstruction, and finally the *tumor entirely disappeared.* That the tumor did disappear there can be no possible doubt. I examined him repeatedly. Dr. A. T. Cabot, of Boston, examined him twice—once in the fall of 1897 (six months after the operation), when he thought he felt "a little hard mass about as big as the last joint of my thumb or possibly a little longer." At this time there were still some obstructive symptoms remaining, viz., irregular and sometimes difficult defecation, occasionally colicky pain and a very decided tendency to bloating and intestinal distention. Dr. Shattuck, to whom Dr. Cabot sent him at this time, could not feel any tumor or thickening. Four months later there was absolutely no sign of a tumor and no symptoms of obstruction. Dr. Cabot examined him again and reported: "I examined him carefully, and certainly the little mass I felt at his last visit in October is no longer to be plainly felt. There is a little sense of resistance just inside of your incision, but no more, I think, than such an abscess as he had might have left. There is certainly nothing there now suggesting a new-growth. The perfectly easy action of his bowels makes me think that there can be no real obstruction there at present." This states and sums up my own findings and opinion of his condition exactly.

For nearly six years he was in good condition and free from any tumor and symptoms of obstruction. Then gradually he began to have a return of his distention, frequent belching, poor digestion, colicky pains and increasing difficulty in having a bowel movement. This went on for about six months. During this time one could feel a slowly growing tumor, which was oval in shape, quite movable, not sensitive to the touch, and which was located in the region of the sigmoid in the left iliac region. The feel was very different from, and its location was higher than, the first tumor seven years before, and while the first tumor was

quite fixed and undoubtedly to the outside of the rectum, this one was decidedly movable and seemed to be *a part of the sigmoid.* He had now a left inguinal hernia and a very large ring which made it almost impossible to retain the hernia by a truss. Obstruction symptoms became progressively worse, until finally he had almost complete obstruction of the bowels. It was evidently necessary to resort to an operation for relief. He entered St. Luke's Hospital nearly seven years after his former "attack" and operation, and asked that the tumor be removed.

Condition when Admitted. A rather pale, stout, flabby man of medium height. His lungs are normal; the heart action is rather weak, his heart muscle is decidedly below par but the valves are good and the action of the heart is regular, the organ itself is enlarged; liver and spleen normal; urine is normal. The abdomen is decidedly distended and he belches frequently. General tympany except over the course of the colon; the lower colon is quite dull. In the left iliac region there is a large oval mass just inside and a little below the anterior superior spine. This mass is hard, generally oval in outline, with its long axis directed obliquely downward and inward; it is movable and not tender to the touch. No enlarged lymphatic glands can be felt. The patient states that it is with the greatest difficulty that he can have an evacuation from his bowels; enemas are necessary and he finds he can receive and retain very little water without it causing great pain. He passes some mucus with his stools but no blood nor pus. He has increasing difficulty in passing his urine. There is a large left inguinal hernia which is not completely reducible. Examination by rectum reveals nothing except that the rectum is empty and that it is ballooned.

The operation was done the day after his admission to the hospital. Ether anesthesia was used. A left longitudinal incision along the outer border of the left rectus abdominis muscle was selected. As was supposed, the tumor involved the sigmoid flexure. It was found to be an enlargement which was solid and which seemed to involve the whole periphery of the colon equably; it was about 14 cm. long and about 6 cm thick (diameter). It

was adherent to the fundus of the bladder and the coil of intestine which escaped through the left inguinal canal was also adherent to it; the mesentery of this intestine was very extensively and firmly united to it. After great difficulty and with a very tedious dissection the adhesions were finally severed and the tumor freed. It was then removed and the severed ends of the colon united by an end-to-end anastomosis. The sac of the inguinal hernia was also dissected out and a modified Bassini operation was done. The operation was a tedious and a long one, but the patient stood it very well. The day after the operation the patient's abdomen was somewhat distended, but he passed considerable flatus during the day. The second night be began to vomit and notwithstanding several washings out of the stomach he continued to vomit. Distention of the abdomen was so considerable that I ventured to pass a rubber tube and wash out the colon above the anastomosis. This did not, and nothing else I could do, relieve the complete paralysis and stasis of the bowels however; on the fourth day after operation his heart showed such unmistakable signs of weakening that I determined to open his intestine. Accordingly, under Schleich's local anesthetic, I made an incision in the left abdomen and drew out a knuckle of the colon just below the splenic flexure, fixed it to the skin and opened it. This little operation was, however, too much for the patient; he fell into a coma from which he did not recover for several hours. He died the fifth night after his operation. Myocardial weakness was exhibited in the usual classical symptoms the last day of his life.

I believe if I had done, as I intended to do, an ileocolostomy after removing the tumor, the patient might have lived. When I mentioned this possibility to him before the operation he begged to urgently that I should not do this that I was moved against my better judgment to make an immediate anastomosis. After such long and almost complete damming up of the whole intestinal tract immediate and complete drainage would certainly have been best. The pathologist's report will give a complete description of the tumor, but I would like to emphasize the fact that

when examined immediately after the operation the tumor mass presented the gross appearance of the colon which had been almost entirely occluded by enormous thickening of its muscular walls; the lumen had been reduced to a canal that would scarcely admit my little finger (about 0.5 cm.). *There was absolutely no ulceration of the mucous membrane and this layer appeared quite normal.* No cicatrix nor bands of fibrous tissue were found macroscopically in any of the coats. Only one large lymphatic gland was found in the mesocolon opposite the tumor.

The especially interesting and important point is that the tumor was formed *in the walls* of the intestine, and that the stricture of the sigmoid was produced by, and exactly at the site and for nearly the whole extent of, the growth or thickening of the muscular tunic of the intestine. *The stricture was not below the growth but within, and produced by, the growth.*

Report of the Pathologist, Dr. A. L. Kotz.

The specimen was a spindle-shaped tumor involving the entire circumference of the intestine, 14 cm. in length and 5.5 cm. in its thickest diameter. The lumen of the intestine at its most constricted portion was less than 1 cm. in diameter. On section it was found to be a hyperplasia of the various layers of the intestinal wall with numerous small granular foci in the outer tunic.

The mucosa was intact throughout the entire extent, but very much puckered, and with the submucosa, which was also in excess, formed a thickness of 0.7 cm. This surplus of membrane evidently resulted from contraction of the longitudinal muscular and serous layers, as like conditions were also found in the circular muscular layer and in the mesosigmoid.

The muscularis formed the greater bulk of the tumor. The circular layer was 1 cm. in thickness. The bundles of fibres were broad, flat, and compact; this also was due to a crowding of this layer from shortening of the intestine.

The longitudinal layer, about 0.5 cm. in thickness, was very compact and closely united with the circular layer. Its outer surface was in some places more or less blended with the fibrous

tunic of the serosa and in others separated from it by granular foci. These deposits also penetrated into the muscular substance.

The serous tunic including the subserous connective tissue formed a dense, uneven, pigmented layer, of variable thickness, and contained numerous granular foci. It formed a tense covering of the tumor, as was apparent from the extreme eversion of the intestine in the longitudinal section. This too explains the crowding of the other layers and mesosigmoid. That the active

A, mucosa; *B*, internal muscular layer; *C*, external muscular layer; *D*, mesosigmoid; *E*, tuberculous foci; *F*, cicatricial tissue.

etiological factor was here located is evident, as will also be seen by the histological findings.

The mesosigmoid contained a large amount of connective tissue with most of its fibres running visceroparietally. From its appearance this was more of an accumulation than actual hyperplasia, and evidently resulted from contraction of the intestine. The mesenteric glands found were few in number and slightly enlarged.

The histological changes, like the gross findings, were mostly

confined to the fibrous tunic of the serosa and external muscular layer. This was found the seat of a chronic tuberculous inflammation extending over the entire tumor, as was evidenced by microscopic findings, as follows: A high degree of capillary engorgement, small-cell infiltration, hyperplasia and pigmentation; granular foci, consisting of lymphoid, epitheloid and giant cells. In the latter tubercle bacilli were demonstrated and areas of cicatricial tissue due to the healing of old tubercles. The connective tissue throughout the entire tumor was hyperplastic, more marked in the outer than inner layers. The muscular tissue predominated, it was pale, the nuclei elongated and stained poorly. The epithelium was well preserved. The solitary and mesenteric glands both were slightly infiltrated.

Summarizing from the gross and microscopic findings we have: a tumor of the intestine in which the predominating elements are muscular and fibrous tissue respectively; a tumor resulting from an inflammatory hyperplasia with contraction of the longitudinal muscular and serous layers and thereby causing circumstantial hypertrophy by crowding of muscular elements; a chronic tuberculous process in the external layers of the intestine as the etiological factor.

In accordance with the predominating component elements of the tumor I believe we are justified in considering it a myofibroma.

The etiology of the patient's condition and the pathological explanation of the development of a myofibroma of the sigmoid are to me exceedingly interesting and difficult to meet. The nature of the first tumor—which appeared about seven years before the patient entered the hospital and which completely disappeared after the abscess which developed had been evacuated, drained, and finally healed—is very doubtful. It certainly felt like a solid and quite hard tumor; it was to the outer side of the upper rectum and seemed fixed to the side of the pelvis; it could be felt by a finger passed into the rectum and was below the site of the second tumor. The tumor *entirely disappeared* after profuse suppuration and marked septicemia of the patient.

Several explanations occur to me. The first one is, that it might

have been a left-sided appendicular abscess; the findings at the second operation would hardly bear this out, however. A second suggestion is, that the tumor really was a new-growth from the side of the bony pelvis, which by pressure produced a closure of the lumen of the rectum high up; infiltration of the cellular tissue about the rectum resulted, infection from the rectum or colon followed, suppuration and the abscess came as the natural sequence; relief of the abscess with subsequent resolution affected the tumor as well as the other tissues in the immediate neighborhood, and gradual absorption may have occurred in the tumor. Mixed toxins must have been present in abundance, a sort of Coley's fluid may have been developed, and a cure of the original tumor resulted. This view would afford a partial explanation of some of the extraordinary hypertrophy of the muscular layers which finally grew to such remarkable thickness that a tumor was formed and the intestine was again occluded. The persistent effort of the colon to relieve itself of the burden of accumulated feces would naturally result in a thickening of the muscles and if long continued very marked hypertrophy might occur. The entire absence of any papillomatous or other growth anywhere in the colon or rectum, and the fact that the mucous membrane of the intestine was quite healthy, indicate that the inflammation did not primarily come from any disease of the lining of the intestine. I searched in vain for extensive matting or adhesions in the pelvis or about the bladder to prove that the abscess which formed nearly seven years before was the result of an appendicitis or other intestinal rupture. True the bladder *was* adherent for a considerable area, but there were no strong fibrous adhesions to the walls of the pelvis and to the lower coils of the small intestine and to the omentum, as there naturally would have been if the old abscess had been an appendicular one. The adhesions were confined to the area between the sigmoid, the pelvic walls, the bladder, and the coil of intestine and its mesentery which passed obliquely across the anterior surface of the tumor.

Dr. Kotz says positively there were tubercular bacilli found in the necrotic spaces in the muscles. This finding may fur-

nish the key to the whole matter. If the former tumor had been a tuberculous infection of the mesosigmoidal lymph nodes, which finally suppurated and were discharged, it is conceivable that an invasion of the coat most affected in trying to overcome the obstruction of the bowels should follow secondarily and remain in the nidus of a persistent chronic inflammation, and hypertrophy of the muscular tissues would continue as a result of increased work resulting from the torsion or deviation, or possibly the adhesions of the sigmoid, already mentioned. That this hypertrophy should be of such extraordinary thickness that it finally formed a *tumor* large enough itself to produce obstruction is certainly remarkable, and, as far as I know, it is unique.

Prof. J. Rotter (*Arch. f. klinisch. Chirurg.*, vol. lxi, p. 866) discusses non-malignant strictures of the sigmoid. He calls especial attention to the fact that the upper part of the rectum and the sigmoid are very rarely strictured by inflammations. It is very rare indeed for a tuberculous stricture to affect the sigmoid or colon, and when this *does* occur the origin of the disease is in the mucous membrane. All of the diseases which produce non-malignant strictures—namely, gonorrhœa, syphilis, tuberculosis, and dysentery—have the common starting-place, viz., mucous membrane.

Rotter says there is scarcely anything in surgical or anatomical literature concerning cases of stricture of the sigmoid resulting from inflammations which do not originate in the mucous membrane, and such cases are exceedingly rare. He credits Graser with the honor of having published the first case of this kind (*Münchener med. Wochenschrift*, 1899, No. 22, and in Langenbech's *Arch. f. klin. Chirurgie*, Band. lix). Rotter in this article publishes three cases of his own, all of them suppurative cases, and they produced strictures by bendings of the lumen of the sigmoid from adhesions and fibrous contractions. In one of his cases there was a one-sided thickening of the intestinal wall *above the stricture*, the stricture itself having been produced by a flexion of the sigmoid and fibrous narrowing. In all these cases the mucous membrane did show signs of involvement, but

Rotter argues that this involvement was only secondary through suppuration and sinuses.

Graser's explanation of these strictures, based upon some very interesting experiments, quoted by Rotter in this article, is as follows: The blood supply to the sigmoid is carried by devious channels from the mesentery to the mucous membrane. They are so arranged that they serve as blood storers—small reservoirs of blood which communicate with small spaces (Lücker) in the mucous membrane. In certain conditions of blood pressure, notably in condition of chronic heart disease, which lessen the force of the blood, these spaces become partially empty and into these gravitate material from the lumen of the intestine. These spaces gradually elongate and enlarge from pressure until diverticula form; infection extends to the mesentery and there an abscess develops; the pressure of this abscess in the mesentery will cause obstruction more or less, according to the size of the abscess. If the abscess be safely evacuated by sinuses into the lumen of the gut, or by incision externally, the contraction of the fibrous tissue which results will cause a thickening in the mesentery and a deviation or bending of the sigmoid, its lumen may be markedly narrowed and finally a stricture will result.

Graser's theory fits the history and the apparent condition of my case in some respects very closely. Neither Graser, Rotter, nor any other writer of whom I know anything has ever reported a case of a genuine inflammatory, or hyperplastic, myofibroma which involved the whole circumference of the sigmoid and which on account of its bulk produced almost complete and symmetrical obstruction of the gut. This case seems, as I said before, unique. It was a genuine and symmetrical tumor, and while of inflammatory origin was histologically a myofibroma.

I present a record of it to the Association on account of this fact and for the sake of provoking a discussion and a relation of the experience and observation of the Fellows of the Association. This may possibly bring to light cases similar to my own and may clear up some doubtful points in the etiology and development of the tumor.

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INFLAMMATIONS ABOUT AND DISPLACEMENTS OF THE SIGMOID.

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The sigmoid loop proper is the movable portion of intestine interposed between the fixed lower end of the descending colon and the upper end of the rectum. Connecting two portions of the intestine that are closely attached to the posterior abdominal wall this loop has a mesentery that varies from one to three and a half inches in length under normal conditions and which not seldom greatly exceeds this.

The length of the sigmoid loop also varies from six to twenty-six or more inches. Morris gives the average length as seventeen and one-half inches. The length and mobility of this loop is such that it may reach to any part of the abdomen. I have seen it in contact with the liver and have frequently found it in the right iliac region during operations on the appendix.

In one case I saw a cancer of the sigmoid in which the tumor lay so close to the left costal margin that the other consultants thought the disease to be at the splenic flexure of the colon.

It is not surprising that this wandering loop should occasionally become adherent over inflammatory foci in various parts of the abdomen and should be fastened in distorted positions.

I have met with seven cases in which the sigmoid was thus distorted and held, and in which chronic obstruction existed. Four of these patients were women and three were men.

The inflammation causing the adhesions originated in the Fallopian tubes three times, in the appendix three times, in the bowel itself (colitis) once.

As the sigmoid by virtue of gravity normally occupies the pelvis, it is not surprising that in six of these cases the confining adhesions should have attached it in that position to the pelvic walls, to the uterus and its ligaments and to the bladder. In the remaining case the sigmoid was bound down over an adherent appendix in the right iliac region.

It was sometimes difficult to say whether the kink that caused the obstruction was at the juncture of the descending colon and sigmoid or at the point where the sigmoid enters the rectum. In several cases it was quite evidently at the latter point, and it was my impression that it was there in all of the cases where the adhesions were in the pelvis.

Symptoms. There was chronic constipation in all of the cases; with pain in the left iliac region. In four of the cases severe attacks of obstipation, sometimes with vomiting, were very troublesome, and in one case the operation was done in the midst of such an attack of complete stoppage.

The distention of the abdomen was often considerable and was especially prominent over the transverse colon. The relief after operation was complete in all cases, but in two of them the patients subsequently, after the lapse of many months, had one or two attacks of pain in the abdomen that were thought to be due to re-formed adhesions. These attacks have not been severe enough nor caused enough obstruction to call for further interference.

The operation requires but little comment. The separation of adhesions should be very thorough and any considerable wounds in the peritoneum should be closed as smoothly as possible to avoid future adhesions.

When in any abdominal operation adhesions are found in and about the pelvis, especial attention should be paid to the sigmoid which should be freed throughout its whole length. In Case IV, failure to attend to this left a condition that required a second operation for its correction.

Case I.—G. A. L., man of fifty-four years. Attacks of pain and obstipation five times in nine months. Difficult urination

in last two attacks, requiring catheter in last one. Following this a constant uncomfortable desire to urinate and great constipation with much pain in abdomen when enemas were used.

Sigmoid adherent to pelvic wall and up onto bladder to its vertex. A considerable portion of sigmoid was held crowded down into the pelvis by the fixation of its upper part. Appendix small and tied up in adhesions. Adhesions all separated and appendix removed. Relieved of obstructive symptoms and bladder irritation.

Case II.—M. T., man of sixty-five years. When about thirteen had dysentery; repeated the next year and lasted two months. For the next thirty years occasional diarrhœa with mucus and blood. For many years occasional attacks of tympanites relieved by laxatives.

Four months ago attack of abdominal pain felt especially in the left iliac region. No tenderness. Pressure over seat of pain brought relief. Since that time five such attacks. Large enemata have always relieved him till last attack, which had lasted three days when I saw him and operated.

Sigmoid adherent along brim of pelvis wall, down alongside of bladder but not onto it.

Adhesions separated with complete relief.

Case III.—Woman of thirty years. Had borne children. For two years pain in back, especially after work. Catamenia regular but painful. Bowels very constipated, often going three or four days without movement.

At operation uterus found slightly tipped backward and somewhat enlarged. Sigmoid adherent along brim of pelvis and out along the round ligament to the cornu of uterus.

Adhesions separated and ventral suspension. One year later she wrote that the operation had been a success.

Case IV.—A woman of twenty-eight years. Operated on by another surgeon on account of distress in lower abdomen. Appendix and right tube and ovary removed. The pain continued. One year later had attack of severe pain in left side accompanied by nausea and vomiting. Bowels did not move for four days.

After this bowels moved only by injections. One month later entered hospital. Had had no movement for six days.

Operation: Some adhesions among the small intestines. The sigmoid curved down along brim of pelvis, then up over bladder and down behind to uterus. To all of these tied by adhesions. All of the adhesions separated and uterus fastened to abdominal wall.

Entire relief of pain and constipation.

Case V.—A woman of thirty-nine years. Operated two years ago by another surgeon for acute appendicitis. Well till one month ago when she began to have pain and flatulency. Bowels constipated. *Operation:* Old adhesions about cecum freed. These did not seem to constrict the bowel. Middle of sigmoid drawn down and kinked by strong adhesions between its mesentery and the broad ligament. These cut with scissors. Moderately retroverted uterus stitched to abdominal wall.

After this bowels easily kept regular by mild laxatives.

Case VI.—Capt. A. L. C., aged thirty-four years. Eight years ago an attack of abdominal pain which laid him up for three weeks. Year or two later a similar attack. He has occasionally since that time suffered from distress in the right side followed by the appearance of blood in the stools. Latterly, these conditions have been more frequent in occurrence and accompanied by distention of the abdomen. Vomited blood on one or two occasions. He is subject to these attacks of pain, which are accompanied by great distention of the abdomen and which seriously interfere with his occupation as a sea captain. When seen, the abdomen was much distended, especially across just below the epigastrium.

The diagnosis was made of appendicitis with adhesions which in some way implicated and obstructed the sigmoid flexure.

Operation: September 28, 1904. Many adhesions found, chiefly in the left lower quadrant of the abdomen. Sigmoid adherent to the peritoneum with coils of small intestine adherent both to it and to each other. After freeing the adhesions of the

sigmoid, the appendix was found extending across the abdomen and adherent to the sigmoid, making a groove across one coil of the small intestine to which it was adherent. Appendix was removed.

This operation was followed by entire relief of symptoms for a year. Since then he has had some slight attacks of abdominal pain not accompanied by distention as before. This would seem to indicate the re-formation of some of the adhesions.

CASE VII.—B. B., woman of forty years. Married, three children, youngest thirteen years. Badly torn at the last birth. Since then uterus has been sewed up and later curetted. For some years has had considerable pain in lower abdomen. Bowels tympanitic.

Ether Examination. Uterus anteflexed and drawn to right. Dilated and curetted. Continued to have pain low down in left side of abdomen; aggravated during defecation. Diagnosis of sigmoid adhesions.

Operation. Sigmoid found tied down by firm adhesions which were freed with scissors. Appendix found curled tightly on itself and removed. This operation followed by entire relief. Diarrhœa on second and third days; after that uninterrupted recovery.

VOLVULUS OF THE SIGMOID FLEXURE. The ends of the sigmoid being fixed at the lower end of the descending colon and at the rectum they cannot shift and accommodate themselves to any twist that occurs in the sigmoid loop.

A lax sigmoid predisposes to constipation and the habitually loaded condition of such a bowel makes it more acted upon by gravity and so more liable to become twisted.

If now this loop is unduly long and makes a complete turn on itself, it presently becomes distended in consequence of the strangulation and may then become so wedged in the pelvis, or indeed may fill the abdominal cavity so tightly, that it cannot untwist.

In one case operated on by me the whole abdomen was tightly packed with the enormously distended coils of a sigmoid that was of great length and size and was twisted two full turns on itself.

A practical question arising in an operation on a case of this sort is how to prevent torsion of the loop in the future.

Considerable portions of intestine have been resected in order to reduce the dangerous redundancy. Such a procedure is, however, I believe, usually unnecessary.

I have in two instances fixed the movable loop to the abdominal wall by drawing it up to the incision and holding it there for a few days by a piece of gauze drawn through a hole in the mesentery. If the middle of the movable loop is thus fixed the danger of future torsion is greatly lessened. It is probable that other adhesions form about the intestine which is congested and in some cases moderately inflamed, and these doubtless help in preventing subsequent volvulus.

When we thus make use of adhesions about the sigmoid, care should be taken that the bowel is left in a good position so that the danger of kinks between it and the descending colon or the rectum shall be, as far as possible, avoided.

Inflammatory Conditions about the Sigmoid Flexure. The sigmoid flexure shares with the rectum a tendency to inflammatory, ulcerative processes in its walls. Both of them are receptacles of excrementitious substances and in both of them accumulations of hardened fecal masses act like foreign bodies to injure the mucous membrane and to induce ulcerations in it. It is not surprising then that the contained material, liquid or solid, occasionally finds its way through one or more of the containing walls and sets up inflammatory processes which lead to abscess formation either between the coats of the intestine or outside.

Sutton (*Lancet*, October 24, 1903) cities two cases in which foreign bodies that had escaped from the sigmoid gave rise to abscess.

In one the abscess was in an epiploic appendage, was drained and finally closed. This occurred in a man of forty.

The other patient was a woman of sixty. A mass in the wall of the sigmoid was resected and found to be an abscess cavity with a little bit of straw in it.

Léjars (*Semaine médicale*, January, 1904, xxvii) also mentions a case of abscess connected with the sigmoid opened by him in 1897. The patient was a young man of twenty-eight who had been suffering with pain in left iliac region for about a month.

In the records of the Massachusetts General Hospital I have found two cases of sigmoid abscess.

CASE I.—J. F., a man of fifty-two years, had suffered for several years from indigestion. Always somewhat constipated. Three weeks before entrance had diarrhœa for one day. No blood noticed.

Six days ago began to have pain just above pubes. Two days ago noticed increase of pain on defecation and urination. Bowels had been kept open daily with cathartics. Temperature 101° F. Leukocytosis, 19,000.

Operation by Dr. D. F. Jones. In the wall of the sigmoid which lay in the pelvis was an abscess containing fetid pus and an intestinal concretion. The wall of this abscess was made up of adherent epiploic appendages. No opening into the gut was made out.

This abscess was drained. During convalescence gas escaped through the opening, showing that there was a communication with the bowel. One year later a fistula still persisted.

CASE II.—Katharine S., sixty-one years of age. Always well till four or five years before, when she began to have some dull pain in the lower abdomen. The uterus now began to prolapse. Her bowels moved daily but with some pain. For two weeks has had severe abdominal pain enough to keep her in bed. Examination showed a mass in the left iliac fossa which was thought to be malignant. Upon operation by Dr. Farrar Cobb this mass was still believed to be of malignant character and a piece of intestine 10 cm. long was resected. In the mesentery of this portion of intestine which was removed was an abscess about the size of a large pea with indurated fat about it; also another smaller focus. The thickened portion of intestine seemed to be purely inflammatory.

Dr. T. M. D., aged fifty-five years, was seen by me in 1897.

He had a history of an attack of abdominal pain lasting three or four days six years before. Since that time he has had occasional pain when he gets tired. These attacks are irregular, three or four times a year. Pain during these attacks severe and accompanied by nausea and vomiting. In the last one there was considerable distention and flatulency. As the attack wore off the pain hung on longest in the left lower abdomen. Since then he has had frequent sense of discomfort in that region. Bowels regular. His weight is about normal.

Examination at that time showed a little mass about as big as two English walnuts, which seemed to be in or close about the sigmoid flexure. I advised an exploratory operation, but before he had decided on anything of this sort he had another sharp attack while in Pennsylvania. Dr. W. L. Estes, of South Bethlehem, saw him and found a distinct tumor in the left iliac region. This was very tender to pressure. Dr. Da Costa saw him at this time and thought the tumor a sarcoma. The tumor gradually worked toward the surface until it finally bulged, with distinct fluctuation, and the abscess discharged into the bowel, but again refilled. Dr. Estes opened it and after a long period of drainage it finally closed.

I did not see Dr. D. again until seven years later. At that time he told me that his bowels had been habitually constipated since the abscess had been opened and in short he had the symptoms which led me to think there were adhesions following the inflammatory trouble. In the region of the sigmoid I found a resistant mass which might be the sigmoid occupied by more or less solid fecal matter, or might be something in the nature of a growth. Absence of cachexia made the existence of a new-growth seem unlikely. I again advised an operation to investigate this condition, to free any adhesions and at the same time to close a ventral hernia which existed at the scar of the old incision. Dr. D. returned to Pennsylvania where he was operated upon by Dr. Estes, who kindly communicated to me the result of his operation. He found the sigmoid bound down and very much thickened, adherent over the bladder as well as along the pelvic

wall. The character of the thickening being suspicious of new-growth, he removed that portion of the signoid, making an end-to-end suture. Dr. D. was taken immediately after the operation with symptoms of acute dilatation of the stomach and lived but five days.

The portion of intestine removed was examined by three pathologists: Dr. Katz, of South Bethlehem, Pa.; Dr. W. T. Councilman, and Dr W. F. Whitney, of the Harvard Medical School. It showed a great thickening of the muscular coats with little purulent foci scattered here and there between the layers.

Dr. Katz found "by counterstaining" many bacilli that he thought were tubercle bacilli.

Dr. Councilman considered the condition one of "proctitis and periproctitis." (He did not know the exact identity of the bit of bowel and thought it came from the rectum. He did not think it tuberculous.)

Dr. Whitney wrote: "The muscular wall was hypertrophied and the serous coat was markedly thickened with dilated vessels and evidence of hemorrhage. Beneath this, in the superficial muscle, were small centres composed of round cells with enlarged capillaries and softening in the centre, suggesting pus. In the midst of these were two or three large multi-nucleated bodies suggesting giant cells, but which differed from those in tuberculosis from the fact that the nuclei were scattered throughout them, and they suggested rather small thrombosed lymph or bloodvessels."

The process seems to me to have been an imflammation of the bowel wall closely analogous to that we see in the rectum (proctitis and periproctitis).

In regard to the treatment of this condition a good deal depends on the anatomical condition found. In case of a circumscribed abscess it is plain that the simple drainage of the abscess may usually be expected to be sufficient.

When the condition is one of serious inflammatory changes of the intestinal wall with thickening and contraction leading to a serious narrowing of the lumen of the bowel with obstructive

symptoms, it is unlikely that a simple exposure and drainage of the inflamed area will bring about a return to normal conditions and function.

Under these circumstances, too, it is evidently difficult to positively distinguish, at the time of operation, between a simple inflammatory condition and an inflammation associated with a cancerous condition of the bowel wall.

In the presence of this uncertainty, and with the aim to certainly and permanently relieve the obstruction, it is reasonable to proceed at once to the resection of the diseased portion of the bowel.

Whether it is wiser after the removal of the diseased area to at once unite the divided bowel by an end-to-end suture or to temporarily establish an artificial anus, after the manner recently advocated by Dr. J. W. Elliot, must be decided by the operator at the time.

It would seem, however, that in these cases where an inflammatory condition exists, and were consequently a primary union is somewhat jeopardized, that the argument in favor of a temporary enterostomy with secondary union of the bowel later is even stronger than in cases of sigmoid cancer.

REPORT OF A CASE OF RESECTION OF THE SIGMOID FLEXURE OF THE LARGE INTESTINE AND ONE-AND-A-HALF INCHES OF THE FUNDUS OF THE BLADDER FOR CARCINOMA.

By W. JOSEPH HEARN, M.D.,
PHILADELPHIA.

Patient, W. T., white, aged forty years, born in Ireland; occupation, hostler. Was called to see him on April 1st, in consultation with his family physician. He was suffering from great distention of the abdomen, with frequent attacks of vomiting of fecal matter. He gave the following history: three days previous he was taken suddenly ill with pain in the upper epigastric region, and toward the right side, accompanied with vomiting. The following day he had a slight bowel movement, but none since, notwithstanding high enemas and purgatives given by his physician. He claimed he had not lost flesh and was absolutely well until the hour he was taken sick, never having suffered from colic or abdominal soreness. I advised an immediate operation for intestinal obstruction. On account of the great distention of the abdomen I was unable to locate the cause of the obstruction. He refused to come to the hospital that day, as well as the next, but on the third day he consented. He was admitted to the hospital and was immediately operated on by the chief assistant surgeon, Dr. Stewart. Rectal examination revealed nothing abnormal; no hernia was found, the heart and kidneys were normal. An incision in the median line was made and the contents of the abdomen explored. A hard, resistant mass was felt in the region of the sigmoid, with collapse of the intestine below and distention above that point. The man's condition was such that Dr. Stewart

decided to make an artificial anus through the median incision for immediate relief, and defer the removal of the tumor for a future operation. This was done and the intestines were allowed to drain immediately by a special method of Dr. Stewart. This method consists in inserting one section of the Murphy button in the bowel in the usual manner, and the other section is inserted in a thin rubber bag with a small opening made in one end; they are then locked in the usual manner. By this method the peritoneal cavity cannot become infected. The Murphy button was removed on the fourth day, the bowel in the meantime having become adherent to the edge of the wound. The drainage was now as satisfactory as in the usual manner of making an artificial anus.

On May 3d, one month later, with the assistance of Dr. Stewart, I dissected out the artificial anus, and through an enlarged incision in the median line I was able to remove about seven inches of the colon, including the tumor, and a large section of the mesentery. An end-to-end anastomosis was made, using Maunsell's mesenteric mattress stitch for a starting point. Before removing the tumor it was found to be slightly adherent to the fundus of the bladder. It was then determined to remove that portion of the bladder. A flexible catheter was introduced for drainage and one-and-a-half inches of the fundus was removed. By holding up each side of the bladder with forceps during and after the amputation there was no danger of urine escaping into the abdomen. The edges of the bladder were brought together with a double row of sutures, catgut for the first row and silk for the last. The catheter was retained in the bladder for several days. The patient made an uninterrupted recovery, leaving the hospital at the end of four weeks.

At the end of seven months the patient was still well, with no apparent return of the disease.

The tumor (microscopically) proved to be cancer. Notwithstanding his assertions to the contrary, I believe he must have had some previous bowel trouble, the lumen was so small that hardened feces could have caused obstruction.

The satisfactory manner with which the interior of the bladder was exposed, and the facility with which any growth could have been removed, has led me to suggest that in a case where plenty of room is needed, and a good view of the interior of the bladder is necessary, I should open the bladder at the fundus, either within the abdominal cavity or external to it, by the Pfannensteil incision—an incision suggested for cosmetic reasons for reaching the pelvic organs. The suprapubic incision may be made transverse or U-shaped, with the curve toward the umbilicus. It extends only through the skin and aponeuroses, and these are separated from the muscles with blunt scissors. The muscles are then separated in a vertical line down to the pubic bone. The facility with which the muscles can be separated is surprising. None of the rigidity exists that we encounter when a vertical incision is made through the aponeuroses. It is absolutely easy to expose the bladder either outside the peritoneum or inside, if for any reason it is necessary to do so. And if opened on the inside, the soiling of the abdominal cavity can positively be avoided.

AN IMPROVED TECHNIQUE IN OPERATING FOR THE REMOVAL OF HEMORRHOIDS.

By LEWIS STEPHEN PILCHER, M.D.,
BROOKLYN, NEW YORK.

THE method which forms the subject of the present communication, in its details, has been elaborated in our work at the Seney Hospital, in Brooklyn, during the past few years. It has given us much satisfaction, and from its simplicity and the freedom from unpleasant complications in the after-course of the cases thus treated, and the certainty and security of the healing which has followed, seems to be almost ideal in its character. The method is developed upon a suggestion by an author in the *International Journal of Surgery* some years ago, but the name of the author or the date of the issue in which the suggestion was published was not noted by me at the time, and I regret my inability now to give the proper credit.

It is true that the old methods of removing hemorrhoidal masses by ligation, or by the clamp and cautery method, have been quite efficient in securing the cure of the disease in all ordinary cases of hemorrhoids; nevertheless, to the critical surgical mind it has always been a fair objection to these methods that they lack that finish, that completeness of fine surgical technique which, in these days of more perfected surgical methods, ought to be given to such cases as well as others. The complete excision of the so-called pile-bearing segment of the rectum in cases of very aggravated hemorrhoidal degeneration, the method of Whitehead, is complete as a surgical procedure. The diseased structure is removed *in toto;* the parts from which the disease is excised are brought together in good apposition; and a primary union is accom-

FIG. 1.—Protruding hemorrhoids of moderate size. (Sketch made in operating-room immediately previous to operation for removal.)

FIG. 2.—The dilatation of the sphincter ani.

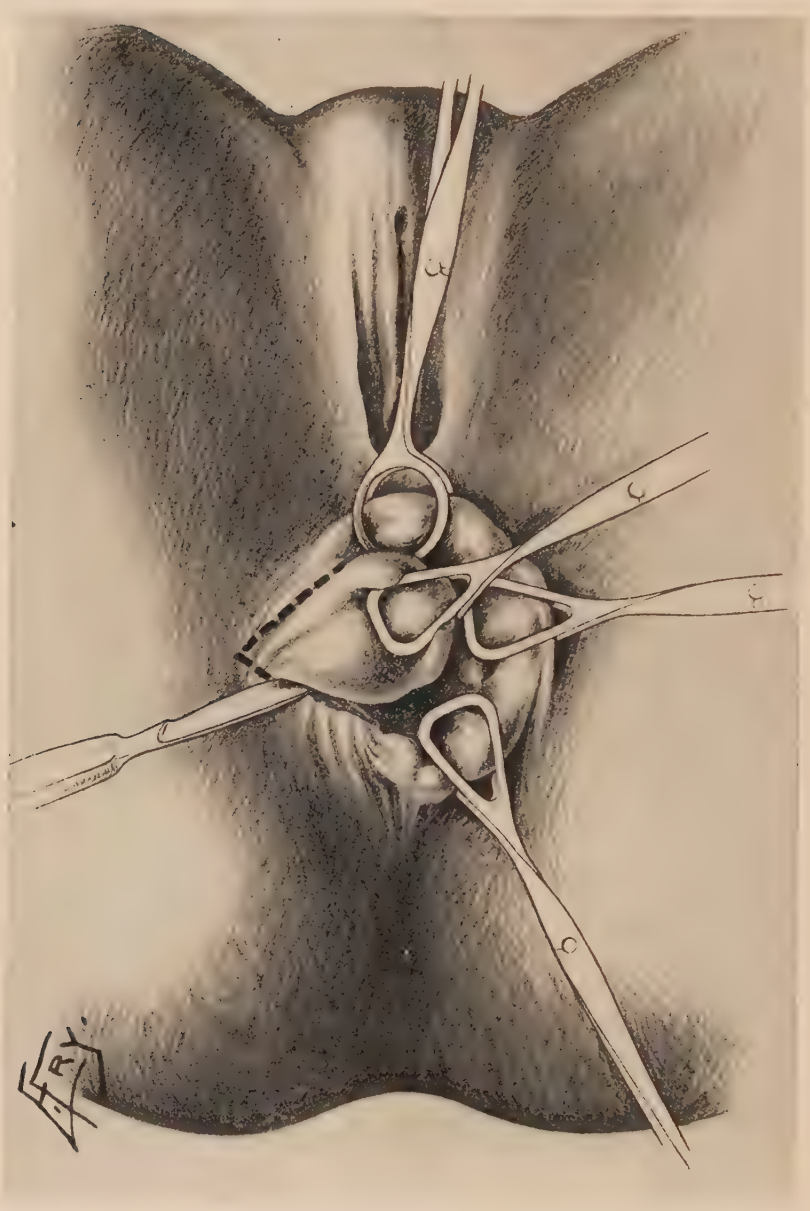


FIG. 3.—The most discrete hemorrhoidal masses seized by ring forceps; one is being loosened from its base externally by the knife.

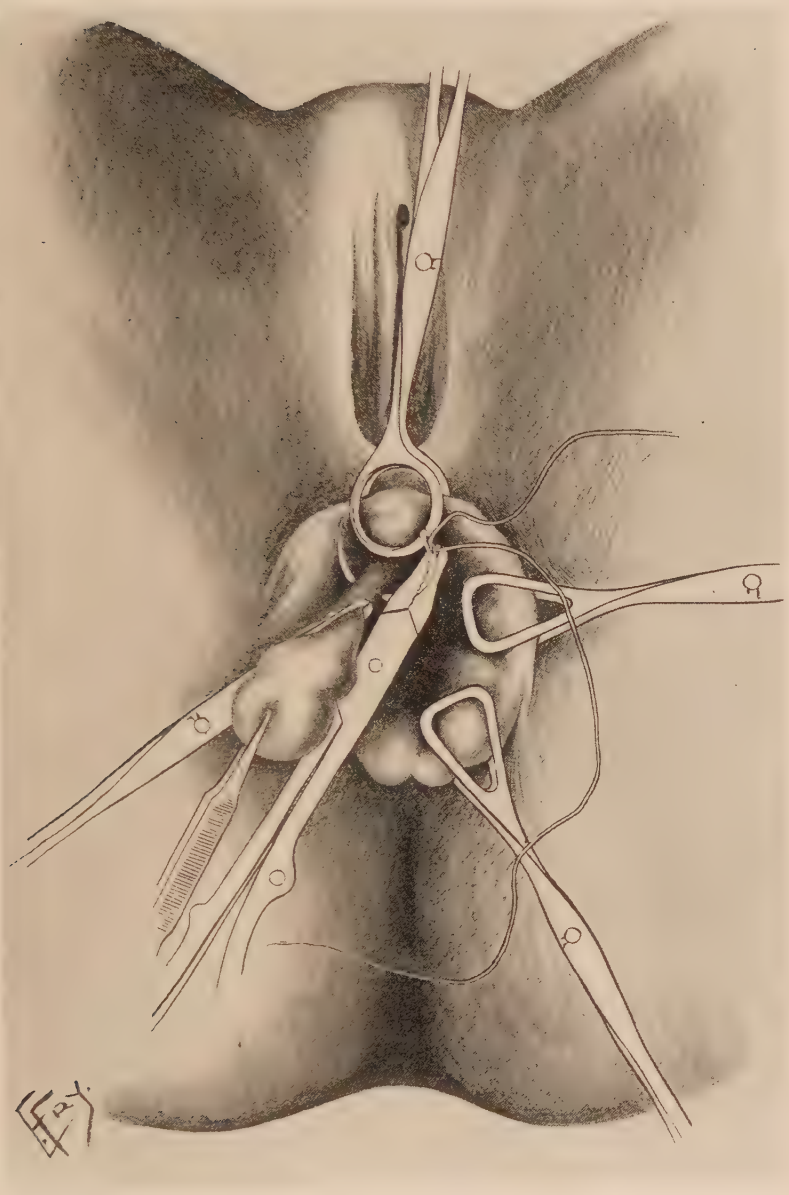


FIG. 4.—The loosened hemorrhoid attached by pedicle of mucosa, which is clamped by hemostatic forceps; a ligature is being passed through the fold of the mucosa above the point grasped by the clamp.

plished. In certain cases it is a method which ought to be resorted to, and must be if perfect relief is to be secured; such as in cases where the lower segment of the rectum is practically converted into a continuous, circular, cavernous tumor, mixed with inflammatory products, in which there are no longer present the discrete masses which are found in most cases that call for attention. It is, however, of the general cases of moderately severe hemorrhoids, such as most frequently apply for surgical relief, for which the method of Whitehead (Fig. 1) is unnecessarily severe and extensive, that the method which I now describe is applicable; cases to which the old methods of ligation or of the clamp and cautery were peculiarly applicable and were most frequently resorted to.

Whatever the method of operating, the antecedent preparations are the same, viz., the emptying of the bowel twenty-four or thirty-six hours previously by a cathartic, and the washing out of the lower bowel by a copious enema not later than eight hours before the operation, so that the rectum is thoroughly empty when the parts are subjected to surgical interference. Complete surgical anesthesia, the exaggerated lithotomy position, thorough dilatation of the sphincter—all these are to be used in any procedure and are to be resorted to in the cases now to be described.

The sphincter having been divulsed (Fig. 2), the lower segment of the rectum rolls out and is readily and fully exposed to view, so that a full estimation of the nature and extent of the disease is presented.

The next step is also common to all methods; determining how many of the hemorrhoidal masses and what ones should be removed. This is best effected by seizing the projecting masses with as many pairs of ring forceps (Fig. 3) as may be required, according to the judgment of the surgeon. Up to this point nothing peculiar in the method has developed; but from this point my own method begins to present its special features.

One of the masses grasped by the ring forceps (as a rule one located at the posterior commissure of the anus is first to be chosen) is pulled out so as to put the parts at its base well upon the stretch. Since the lower edge of the ring applied to the pile involves the

mucocutaneous junction, as the base of the pile is put upon the stretch there is produced a cone whose apex passes upward to the normal mucous membrane, and its base passes outward upon the normal skin surrounding the anus. Then, a longitudinal incision through the mucous membrane and skin on either side of this cone at the mucocutaneous junction is made (Fig. 3), which passes out onto the skin of the neighboring perianal region so as to include as long and as extensive a triangle of skin as may be required to obtain a desired retrenchment of the redundant perianal skin, when the final suturing of these incisions shall have been done.

Owing to the vertical direction through which the bloodvessels of the lower rectum descend in the submucosa to the margin of the anus, it is possible to make these vertical incisions described on either side of the telangiectatic mass grasped in the forceps without producing much hemorrhage.

Then, beginning with the apex of the little triangular flap of skin that has been marked out, this is dissected up from the fibers of the sphincter to the base of the pile mass above; as the result of this, the mucous membrane on either side of the pile having been divided from the tissue on either side by the preliminary longitudinal incisions, and the skin flap to be removed having been raised up, the continued traction of the ring forceps raises and isolates to a suitable extent the whole pile mass. Now, if into the sulcus thus produced an ordinary pair of Kocher's hemostatic forceps is thrust up so as to grasp the comparatively narrow pedicle of the pile, it will not only enclose the whole of it, but will reach up to the normal mucous membrane above, so that its vascular supply is wholly controlled (Fig. 4). Practically, the situation is the same as when the surgeon applies the clamp for the cautery operation. The portion of the pile that protrudes beyond the clamp is now cut off flush with the clamp by knife or scissors, just the same as in cautery operation (Fig. 5). The special point now presents itself:

Remembering that the chief blood supply of this pile descends into the submucous tissue vertically from above, if, underneath

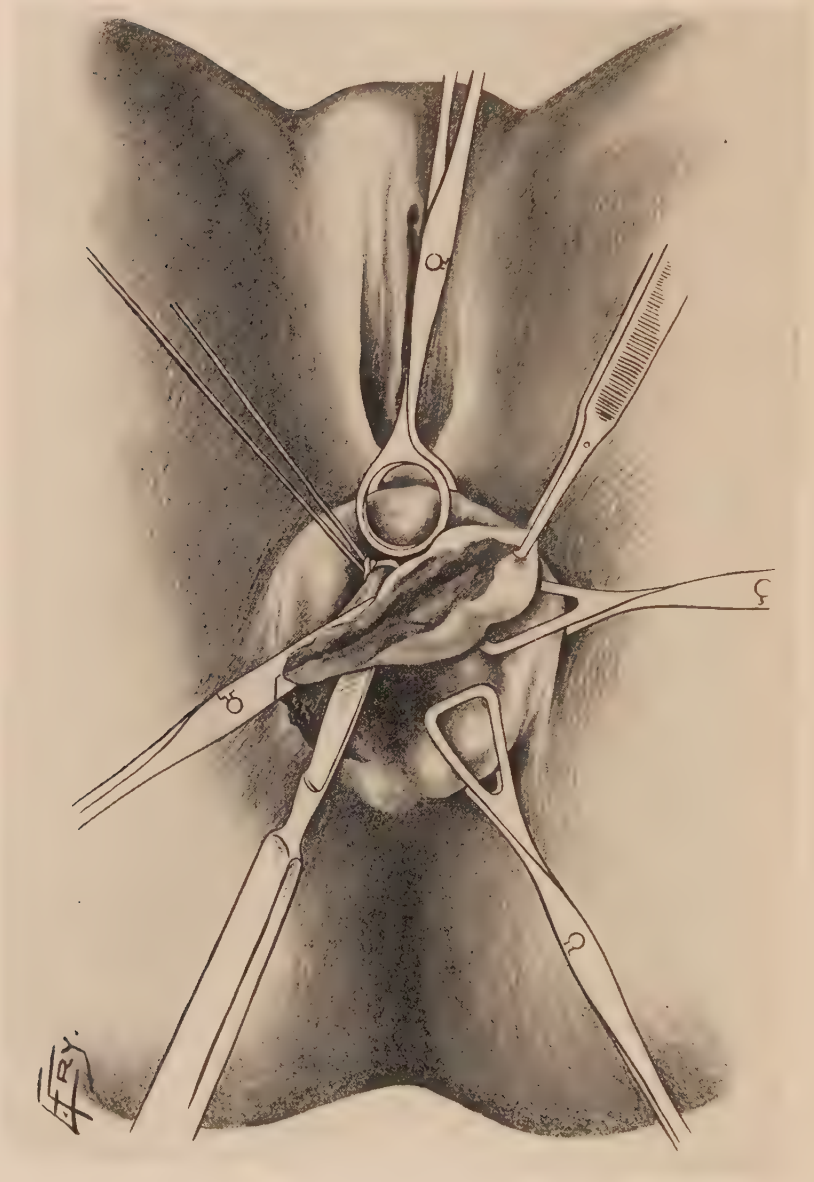


FIG. 5.—The hemorrhoid is cut away.

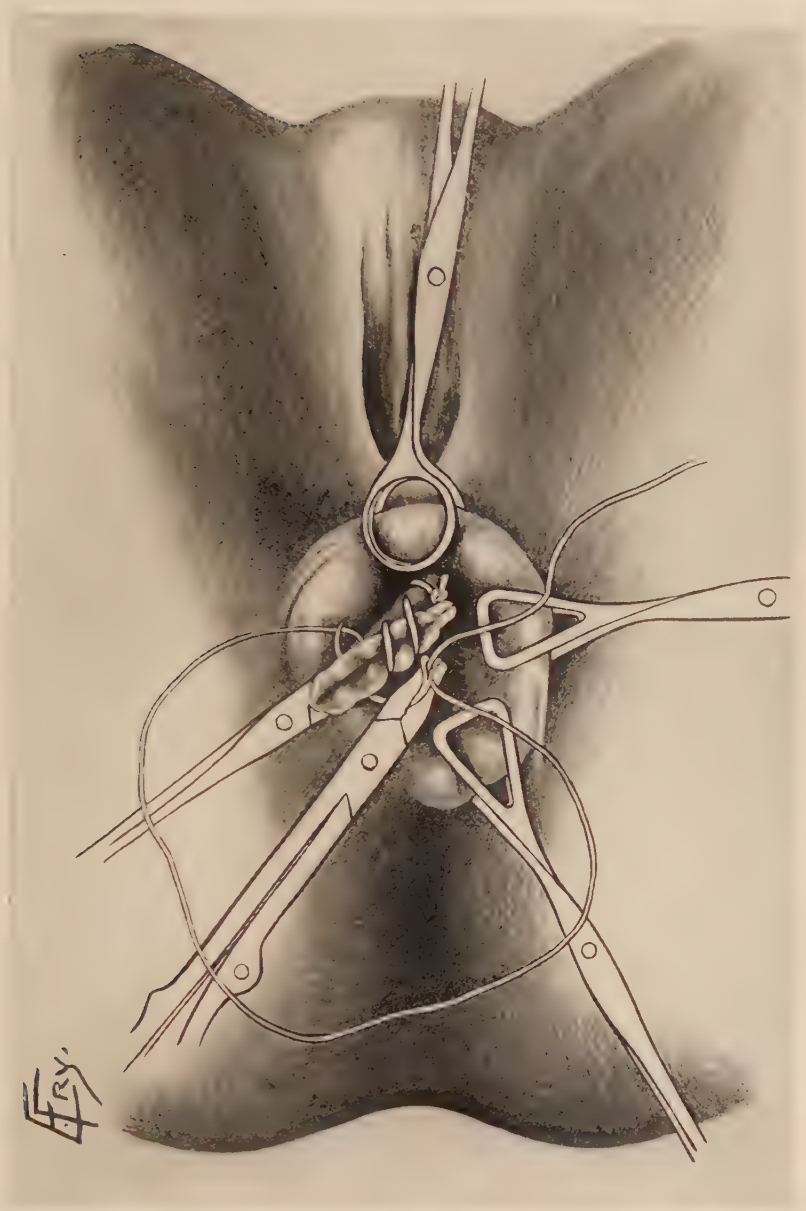


FIG. 6.—The ligature is passed as a running suture over the stump of the pile and beneath the grasping clamp.

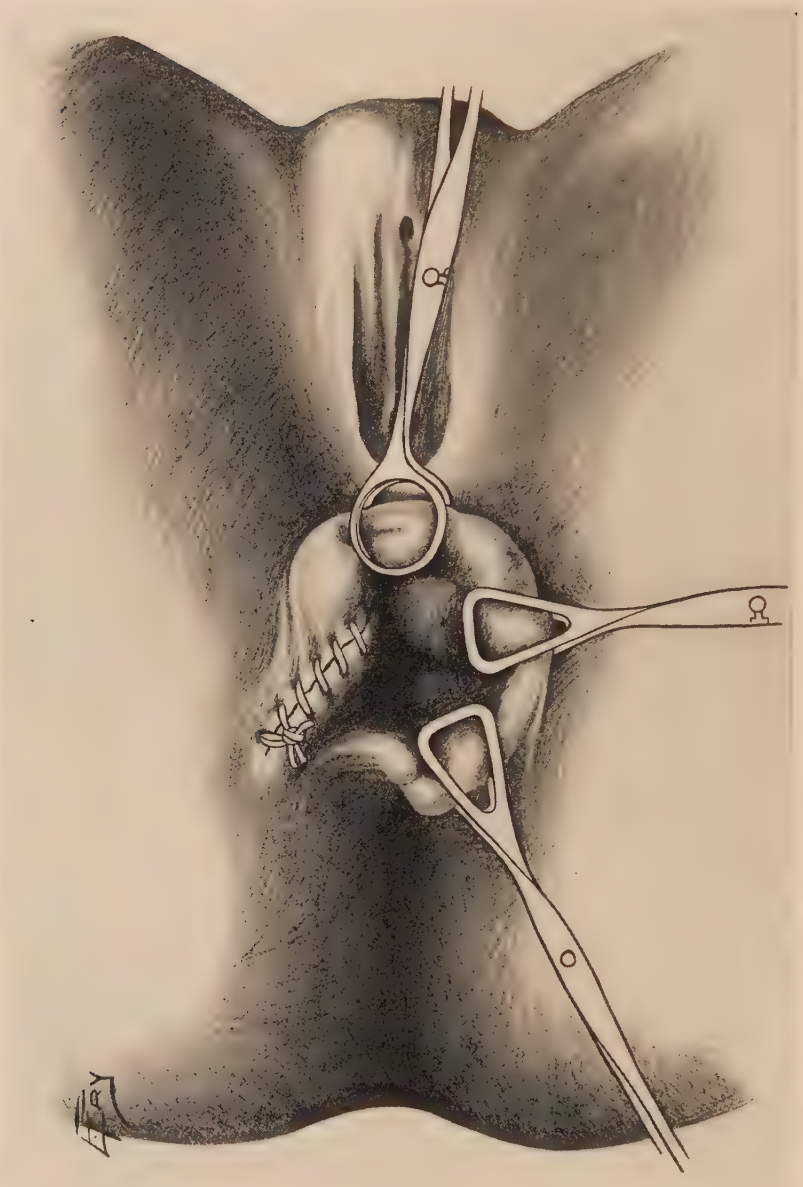


FIG. 7.—The clamp is removed and the suture is drawn up and tied.

FIG. 8.—The completed operation, as presented after the removal of multiple hemorrhoids.

the fold of mucous membrane which is just above the point reached by the clamp, a curved needle armed with a ligature thread is passed well into the submucous tissue (Fig. 4), and being drawn through carries such a thread when it is tied that the main blood supply of the parts below is cut off.

This is the key to the situation—*the passing of this needle through the fold of mucous membrane just above the point reached by the clamp, and the application of the ligature at this point, tied tightly.*

For this ligature chromicized catgut is to be preferred, and it should be long enough to serve not only for this primary point of ligature, but also for the subsequent suturing now to be described.

The needle, still armed with the long end of the ligature thread, is now carried as a running suture around the mass in the grasp of the clamp, passing through the mucous membrane and the tissues underneath the arms of the clamp two, three or four times, as the extent of the disease may seem to require, until all of the tissues grasped by the clamp have been included (Fig. 6). The clamp is now loosened by slight manipulation, and withdrawn, after which the ligature is drawn tight, by which manœuvre the entire site of the pile is included in the line of suture down to the point of the mucocutaneous junction (Fig. 7).

If the incision has been at all extensive, it is well to knot it here and suture the skin incision outward by a separate line of suturing. In the less extensive cases, the original line of suturing can be made to include both the mucous and skin incisions without interruption. Thus, the surgeon has secured himself from the dangers of hemorrhage by preliminary ligature of the vessels of supply ascending from above; the securing of all the tissues of the wound by suture has been provided for by the way in which the needle is passed successively through the tissues which were grasped by the clamp. It may be noted here that if the clamp is not applied with enough force there is the possibility that some of the tissues grasped in it may slip out after the cutting away of the pile mass; this should be thought of in the application of the clamp and the necessary strength of blade and force of grasp should be

secured by the surgeon. My own experience, however, has been that even when such slipping of the cut parts has occurred, it gives but little trouble to secure them by suitable additional suturing, for the parts are well exposed to view and are thoroughly under control.

When the procedure has been completed there results a well and satisfactorily secured wound; the wound surfaces are in apposition, the perianal skin redundancies have been in great part removed, and the traces of the operation present to inspection two, three, or more small sutured wound-lines radiating from the anus (Fig. 8).

In my own experience, the after-history of cases thus treated has been uniformly smooth; much less pain—either immediately following the operation or later—has been complained of by patients than in other methods of operating. The tendency to the formation of hematoma or of œdematous swellings has been comparatively slight, and, thus far, wound infection has been escaped, although it is not to be denied that the work in all cases is done in an infected field owing to the impossibility of perfectly cleansing the parts to be operated upon, or of preventing the subsequent access of fecal materials from above.

The simplicity of the method and its completeness as a surgical procedure have commended it to our judgment, as well as the satisfactory after-course and the completeness of the restoration of the parts to their original integrity.

The subsequent treatment does not differ from that commonly employed in any method of dealing with hemorrhoids. A suppository containing $\frac{1}{4}$ grain of morphine, 1 grain extract of hyoscyamus and 2 grains of iodoform is inserted into the rectum and a compress of iodoform gauze is applied against the anus supported by a larger compress of ordinary gauze and a T-bandage. The bowels are kept quiet by moderate doses of tincture of opium until the third day, when a laxative is administered, the first movement produced by which is rendered easy by the administration of an enema of six ounces of olive oil.

The patient is allowed up at the end of one week.

THE SURGERY OF CARCINOMA OF THE UPPER PORTION OF THE RECTUM AND THE SIGMOID COLON:

WITH SPECIAL REFERENCE TO THE COMBINED SACRAL AND ABDOMINAL OPERATION FOR THE RESECTION OF THESE TUMORS.

By JOSEPH C. BLOODGOOD, M.D.,
BALTIMORE, MARYLAND.

Sufficient time has elapsed to demonstrate clearly that resection has accomplished a certain number of cures of carcinoma of the stomach and large intestines. In the majority of these cases the hope of future progress depends more upon earlier recognition than upon improvement in operative technique. The technique of gastrectomy for carcinoma is most satisfactory. The only partially settled problem is in regard to the extent to which glandular dissection should be carried. At the present time the majority of authorities favor a restricted glandular operation, in view of the higher mortality of the more extensive dissection and the slight probability of a cure when these more remote glands are involved. With carcinoma of the small intestine there is not sufficient experience to formulate positive deductions. Malignant epithelial tumors, anywhere between the ileocecal valve to the anus, are of comparatively frequent occurrence. When the tumor is situated in that part of the large intestine above the promontory of the sacrum, the entire manipulation is performed within the abdomen. These tumors, which arise from the mucous membrane of the large intestine, show little tendency to extend

beyond the peritoneal coat, except at the mesenteric border. Adhesions due to the infiltration of the epithelial growth through the peritoneal coat into neighboring viscera are late complications. In planning for the complete extirpation of these growths, one should resect a very generous portion of the apparently uninvolved intestine on each side of the palpable tumor, because infiltration of the new growth along the submucosa beyond the open ulcer is a common occurrence. The next most important step is to include with this portion of the bowel a large area of mesocolon, whether the glands be palpable or not.

In selecting the place for the division of the bowel above and below the tumor, one should have in mind not only the complete removal of the tumor, but also a proper blood supply after the resection of the mesenteric area. The experience of any surgical clinic and the literature show a comparatively large number of cases in which the tumor had every appearance of curability, but in which an operative death due to gangrene of one or both ends of the resected intestine marred the result. The decision as to the method of suture after the resection is a somewhat difficult one. As a rule, closure of the two ends with a lateral anastomosis is the safer procedure.

As the tumor of the colon approaches the promontory of the sacrum new problems arise. In some instances there is sufficient healthy bowel below the tumor to allow restriction and suture within the abdomen. In other cases, on account of the lower position of the tumor, or its infiltration analward, the restriction can be completely accomplished only by a combination of an abdominal and extra-abdominal or a sacral incision.

This paper is concerned chiefly with the latter group of tumors.

The literature on this subject, with a complete historical review, appeared in 1904, in the *Deutsche Zeitschrift f. Chirurgie*, vol. lxxiii, p. 229, by Ito and Kunika, and by Gouillioud and Faysse in *Revue de Chirurgie*, 1905, vol. xxxi, pp. 711 and 107. As far as I have been able to ascertain, these two articles cover the most important contributions to the literature.

In the past, surgeons have been concerned chiefly with the

extirpation of the affected bowel with a generous portion above the tumor, and below the tumor the extent of the removal has varied from four centimeters to the entire rectum, including the sphincter. In addition, they have made very extensive dissection of the tissue between the rectum and the sacrum.

These surgeons have been content either with an inguinal colostomy or a sacral anus.

In approaching my cases since 1904, I have endeavored not only to fulfil the requirements of a complete removal of the malignant disease, but also to attempt, after its removal, a restoration of the continuity of the bowel by an end-to-end anastomosis.

In my first case, in November, 1904 (Case 3), I was able to perform the complete resection of a carcinoma situated just above the promontory of the sacrum entirely within the abdomen. The condition of the patient, however, forbade, at that time, an attempt at suture. At the present writing, eighteen months since operation, the patient is content with the colostomy. In a second case (Case 1), in July, 1905, it was necessary to finish the resection through a sacral incision. In this instance, it was possible to save, with a good blood supply, eight inches of the lower end of the rectum, which rendered an end-to-end suture of the sacral wound impossible. The result at the present time is unusually satisfactory. In the third and most recent case (Case 2) it was possible to resect and suture entirely within the abdomen.

Compared with the published cases these three tumors would have received the same complete resection, but with an inguinal colostomy or sacral anus. In two of my cases, complete restoration of the continuity of the bowel was accomplished. In the first case, this procedure would have been attempted had the condition of the patient permitted it.

A careful study of the cases in the literature, I believe, will justify the following criticisms: (1) Colostomy has been performed too frequently as a primary operation. Colostomy is not indicated unless the patients are first seen in a condition of acute obstruction, or their condition is so critical from chronic obstruction that a prolonged operation is contraindicated. If possible, the entire

operation should be performed at one sitting. (2) It is unnecessary to ligate the vessels so far from the mesenteric border of the colon. Resection of the glands up to this point is not indicated. If they are involved, my experience demonstrates that the condition is hopeless for an ultimate cure. The disadvantage of ligation of the vessels so far from the colon is due to the fact that, after such a ligation, a more extensive resection of large intestine is necessary to leave bowel with proper circulation. (3) Too much bowel below the tumor is removed.

If one restricts the resection of the large intestine above and below the growth to that necessary only for the complete removal of the disease, and ligates vessels as they are met with in the proper dissection of the mesentery with its glands and the fat between the rectum and the sacrum, it will be possible, in a large number of cases, to restore the continuity of the bowel by an end-to-end suture.

The pathological examination of a number of specimens and of the zone of mesenteric involvement which I have made apparently confirms the statements in the previous paragraphs. That is, in this somewhat restricted operation the new-growth is given sufficient margin, at the same time the circulation of the remaining portion is not impaired, and, in the majority of cases, there may be restoration of continuity.

When the tumor involves the rectum below the promontory of the sacrum, at which position the posterior portion of the bowel has no peritoneal coat, it infiltrates quickly through the wall of the bowel into this tissue. The complete removal of all the tissue between the rectum and sacrum should never be restricted. There is every evidence to indicate that this is accomplished by the combined method better than by the sacral route alone.

DISCUSSION OF CASES

CASE 1. *Pathol. No.* 6550. *H. R. Adenocarcinoma of upper part of rectum; resection by combined abdominal and sacral route; closure of peritoneum about colon in pelvis; end-to-end suture of*

colon to rectum in sacral wound; temporary colostomy above; drainage of sacral wound. Recovery. July, 1906, *twelve months well; stools per rectum.*

This observation represents the typical combined abdominal and sacral method, with the addition of a successful extraperitoneal end-to-end suture in the sacral wound.

The clinical history was almost, of itself, sufficient to make a diagnosis. The patient was a white male, aged forty-three

FIG. 1.—Case 1. Tumor portion of the rectum, at promontory of sacrum. T, tumor; B, bladder; S, promontory of sacrum.

years, and for one year had suffered from constipation and ribbon stools. The appearance of blood in the stool two weeks ago made him consult his physician, Dr. Humrichhouse, of Hagerstown, who immediately, suspecting the nature of the trouble, referred him for surgical treatment.

On examining the rectum with the finger, an obstruction was

met about ten centimeters from the anus; it felt something like the cervix of the uterus; the tissue filling the lumen of bowel was hard and granular; it encircled the entire bowel; the mucous membrane ended abruptly, and no infiltration could be felt beneath it. The tumor seemed movable.

FIG. 2.—Case 1. Position of division of colon above tumor. X, ligation of artery a short distance below the lower branch of the ramus descendens.

The position of this tumor was one in which, in the past, many surgeons have operated from below by the Kraske method. From my somewhat limited experience I had become convinced that a tumor in this position should at least be first attacked from above.

Operation. The peritoneal cavity was opened to the outer border of the left rectus, the patient placed in a high Trendelen-

burg position; without much difficulty, all the intestines were packed in the upper portion of the abdomen; the exposure of the pelvis and its viscera was most satisfactory. The tumor (Fig. 1) was situated at about the promontory of the sacrum, and but slightly movable, but on palpation there was no evidence of infiltration beyond the wall of the bowel. No glands could be seen or felt in the mesocolon; the ascending colon was withdrawn from the wound and the peritoneal cavity protected with gauze; the colon was clamped just below the lower branches of the ramus descendens (a branch of the interior mesenteric, see Fig. 2, at *X*); this selection ensured a good blood supply of the upper loop of the colon; the division of the colon was made between two clamps; the divided ends were inverted with catgut reinforced with silk; the clamps were removed. The upper portion of the colon was then pushed back into the peritoneal cavity with a piece of gauze; the lower portion of the colon was pulled farther out of the wound and the division of the mesentery begun. At first the peritoneum on each side of the mesocolon was divided and stripped back, this exposed the fat and vessels; the vessels were clamped about three centimeters from the bowel, first two branches of the sigmoid and a number of branches of the superior hemorrhoidal artery; they were immediately tied on both sides; there was no hemorrhage. This left sufficient tissue in the mesentery to include possible metastatic glands. The division of the peritoneum was carried down on each side of the tumor, some distance from it, over the sacrum to the bladder. The division of the peritoneum was not completed between the rectum and the bladder. With a piece of gauze the mesentery and the fat over the promontory of the sacrum were pushed forward and the middle sacral artery exposed, doubly clamped, and ligated; the sacrum was completely stripped of the tissue between it and the rectum. There was practically no bleeding. This completed the dissection from above. The patient was then transferred to Halsted's perineal table. A straight incision was made over the coccyx and sacrum; the former and part of the latter bone were removed. The rectum was then divided across eight inches from the anus; the lower portion of the

rectum was left undisturbed. As the tumor was situated some distance above, the dissection of this lower portion of the bowel below the tumor was carried rather closely to the wall of the rectum, exposing, in order, the prostrate, the right seminal vesicle, and the bladder; the right vas deferens was accidentally divided and immediately sutured. The peritoneal cavity was opened into between the rectum and the bladder anteriorly. These had not been dissected from above. The operator then introduced his left hand into the peritoneal cavity and withdrew the bowel above the tumor. Dr. Sowers, who assisted me, now opened the abdominal wound and pushed the now isolated portion of colon and rectum downward. As the entire dissection of the bowel from the sacrum had been done from above, this portion of the operation was rapidly performed. The tumor with the portion of the colon and rectum having been removed, Dr. Sowers passed the colon into the sacral wound, where it was held by an assistant, in close proximity to the stump of the lower end of the rectum. The operator then changed gloves and sutured the divided peritoneum in the floor of the pelvis around the colon, closing this portion of the wound absolutely. Dr. Sowers then proceeded to perform a temporary colostomy in the lower portion of the abdominal wound and to close the abdominal wound. The operator at the same time proceeded with an end-to-end anastomosis of the colon and rectum in the sacral wound. The anastomosis was made, first with a continuous catgut suture through all tissues, approximating mucous membrane to mucous membrane. This suture was reinforced with interrupted catgut, approximating the peritoneal coat of the colon to the outer wall of the rectum. Then the divided tissue in the pelvic floor, muscle, and fascia were sutured about the anastomosed bowel and the sacral wound partially closed with drainage to the suture (Fig. 3). There was no shock following the operation.

Postoperative Notes. The patient required catheterization for about two weeks. A part of the suture in the sacral wound broke down and there was a fecal fistula. At the end of five weeks, practically all the fecal matter was passing naturally

per anum; there was a small sinus in the sacral wound and in the colostomy, from which there was discharge of gas and some fecal matter. The patient left the hospital at this time. For a number of weeks the patient irrigated himself through the colostomy wound and through the anus, in order to evacuate completely the bowel. There was a slight spur formation anteriorly at the

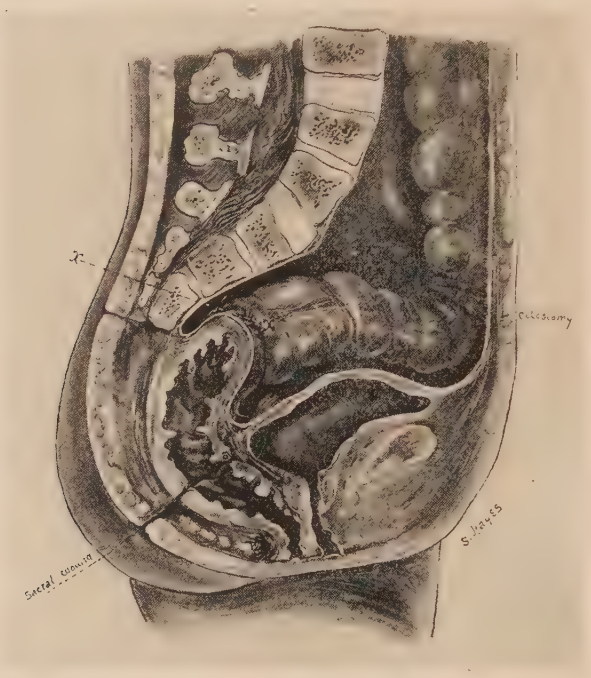


FIG. 3.—Case 1. Diagram illustrating relation of parts after operation in Case 1. X, suture of peritoneum around colon in floor of pelvis; SS, end-to-end suture of colon to rectum in sacral wound.

position of the anastomosis. Then it was necessary to irrigate the bowel through the anus only.

At the present time, July, 1906, eleven months since the operation, the patient takes one enema daily; the sacral wound has closed; there is a minute mucocutaneous sinus at the colostomy, through which gas occasionally passes; there is no stricture at the position of the anastomosis, and the anterior spur formation

is very thin. I believe this can be divided in a few months, when the daily enemas will have become unnecessary.

Pathology. The mucous membrane surface of the superficial carcinomatous ulcer is illustrated in Fig. 4. There was 4 cm. of healthy bowel below and 8 cm. above, measuring from the junction of the ulcer and mucous membrane. The ulcer measured longitudinally 5.5 cm. It was a superficial fungous growth, and in some places had infiltrated to the fat in the mesentery. The enlarged glands show no metastasis under the microscope. Fig. 5

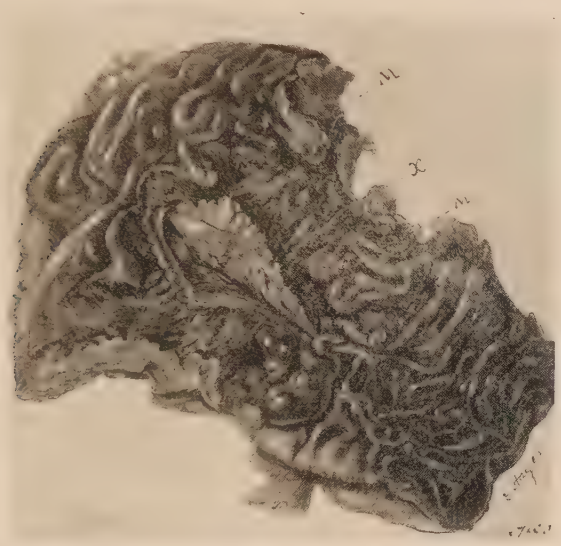


FIG. 4.—Case 1. Sketch (pen-and-ink) of bowel removed in Case 1. Mucous membrane surface after longitudinal division. M, boundary between mucous membrane and carcinomatous ulcer; X, a longitudinal cut through carcinomatous ulcer.

is a photomicrograph from the junction of the mucous membrane and the epithelial growth.

CASE 2. *Pathol. No.* 7335. *Mrs. C. Adenocarcinoma of colon above promontory of sacrum; intestinal obstruction; first operation, median colostomy; second operation, resection and immediate end-to-end suture through abdominal cavity only. Healing with complete restoration of continuity of the bowel.*

This patient, aged thirty-two years, was admitted to the hospital on the eleventh day of an attack of intestinal obstruction. In view of the history of an abdominal suspension of the uterus eight years previously, the possibility of an obstruction from adhesions was considered. For one year the patient had had attacks suggesting slight obstruction; constipation, with belching of gas,

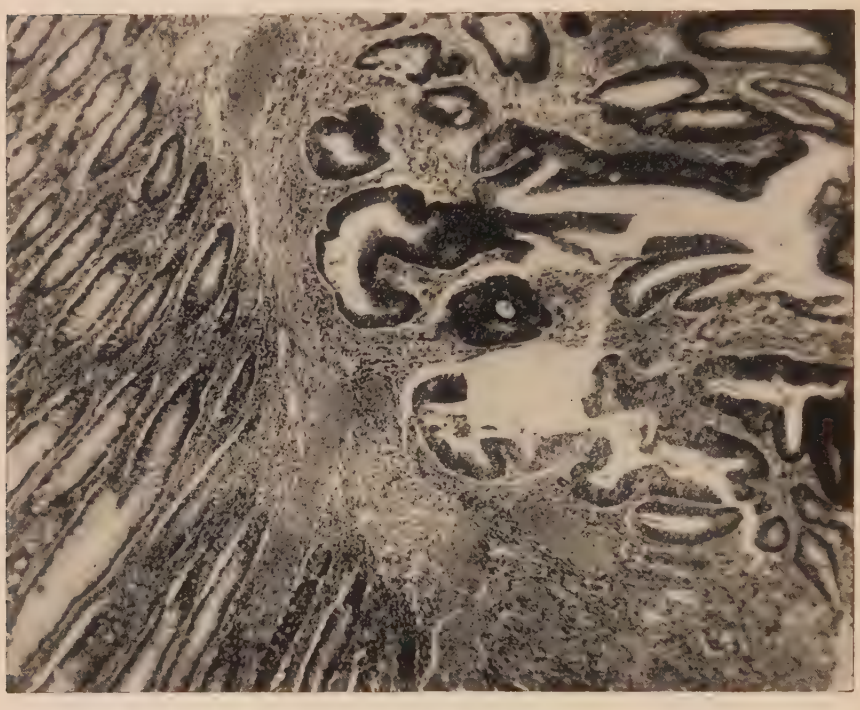


FIG. 5.—Case 1. Photomicrograph of section through carcinomatous ulcer and normal mucous membrane. M, mucous membrane, slight hypertrophy of glands; X, adenocarcinoma.

and distention. However, the recent appearance of ribbon stools and blood were indications of a new-growth. The clinical picture suggested an obstruction of the large intestine; the long duration (eleven days), combined with a fair general condition and but moderate vomiting, excluded an obstruction of the small intestine. A rectal examination, before and during ether narcosis, was

negative. Rectal enemata before narcosis failed to get gas or fecal matter. When the patient was under ether narcosis I passed a rectal tube and withdrew some gas and fluid fecal matter. However, in spite of this result, it seemed wiser to operate. I have frequently observed this in obstruction from new-growth in the rectum or colon. On opening the peritoneal cavity in the middle

FIG. 6.—Case 2. Diagram of operative findings in Case 2. T, tumor above promontory of sacrum; X, line of division of bowel above and below tumor; Lig., position of ligature.

line, the large intestine was almost of giant size; the transverse colon was U-shaped; the base of the U was adherent to the anterior abdominal wall above the uterus, near the pubes; it was necessary to separate these adhesions and empty the large intestine of its gas and fecal matter before one could make an exploration; this

was easily done without soiling the peritoneal cavity. The opening was made in the transverse colon, at a position which would answer for a colostomy in the upper portion of the median wound. On exploring the pelvis a hard tumor was felt in the sigmoid colon some four inches above the promontory of the sacrum. The patient's general condition contraindicated resection at this time. A temporary colostomy was made in the upper portion of the median wound, because in this position it would interfere less with a second operation on the left side.

The second operation was performed May 26, 1906, about six weeks after the first. The former wound had healed, and it was possible to irrigate the colon thoroughly through the colostomy opening. The peritoneal cavity was opened through the outer border of the left rectus; fortunately, the ascending colon was found collapsed. A number of loops of small intestine, however, were adherent to the mesentery of the ascending colon and splenic flexure. These were separated. The patient was placed in the high Trendelenburg position. On account of the colostomy and the adherent small intestines it was much more difficult to empty the pelvis and get the exposure noted in Case 1. Fortunately, the tumor in the sigmoid colon was situated sufficiently high to allow a resection, giving the tumor sufficient margin through the peritoneal cavity alone. On account of its situation, as shown in Fig. 6, I believe that a more extensive operation by the combined abdominal and sacral route would not have given this patient any greater assurance of a permanent cure than the less extensive resection which I performed. The colon was divided between two clamps at the same position noted in Case 1, and following the same method; the lower portion was then withdrawn from the wound, and the mesentery divided, as in Case 1, down almost to the promontory of the sacrum; the sigmoid artery was ligated, but not the superior hemorrhoidal. The circulation of the two ends of the colon after the resected loop had been removed was so good that an end-to-end anastomosis was performed. The shortness of the lower loop would have made a lateral anastomosis very difficult. The anastomosis was performed first with a con-

tinuous suture of catgut beginning at the mesenteric border. This continuous suture was knotted in five or six places, in order to prevent puckering and a later stricture. Fortunately, the two ends were about the same size, and a perfect approximation was not difficult. This suture was reinforced with interrupted stitches of silk, including all the coats but the mucous membrane, approximating peritoneal surface to peritoneal surface.

FIG. 7.—Case 2. Photograph of fresh specimen. Outer surface of bowel and tumor removed.

Now that the suture was finished, it was a question just what to do. Should the colon be dropped into the peritoneal cavity and the wound closed? Should it be dropped into the peritoneal cavity with gauze drainage? It was found that the position of the suture could be lifted into the lower portion of the wound without tension. In this portion of the wound through the outer border of the left rectus the peritoneum was separated from the muscle by considerable fat; it is a position in which the peritoneum begins to leave

the abdominal muscles; the peritoneum can be easily separated; it has a good blood-supply from the fat in the space of Retzius on the median side, and the inguinal canal on the outer side. For this reason it was decided to place the bowel at the position of the suture almost extraperitoneal, by pushing the parietal peritoneum back and suturing to the mesentery of the colon on each

FIG. 8.—Case 2. Photograph of mucous membrane surface after longitudinal division showing superficial carcinomatous ulcer.

side of the suture, with gauze drainage to this point; above and below the peritoneum was closed as usual. In a suture of this kind, no matter how carefully it is performed, there is a certain possibility of a leak. The method employed in this case protected the peritoneal cavity most effectively, and if a fecal fistula

were to form, the superficial position of the colon would make this fistula much less dangerous and the probabilities of healing without stricture formation more probable.

Postoperative Notes. For seven days the patient was given by mouth nothing but albumen and water. Fecal matter appeared in the rectum on the tenth day. At the present time, three weeks after operation, the colostomy wound has almost closed; there has been no leakage at the position of the suture; all the fecal matter

FIG. 9.—Case 2. Painting of specimen in case 2. Section through part of ulcer to illustrate constriction and non-infiltration of tissue outside of wall of bowel.

passes per rectum with the aid of an enema; the cavity left after the removal of the gauze drain down to the suture is healing rapidly by granulation; the size of the fecal matter which passes per anum is sufficiently large to indicate that the lumen of the anastomosis has not contracted.

Pathology. The tumor which produced a constriction of the sigmoid colon is a superficial fungous ulcer. The outer surface

showing the contraction is well illustrated in Fig. 7, and the inner surface in Fig. 8. The tumor is an adenocarcinoma of a low grade of malignancy. It has not infiltrated through the wall of the colon, and no involved glands could be found in the mesocolon. Fig. 9 is from a painting of the tumor.

FIG. 10.—Case 3. Position of tumor just below the promontory of sacrum in Case 3. S, promontory of sacrum; T, tumor; U, uterus; B, bladder.

CASE 3. *Pathol. No.* 5907. *Adenocarcinoma of the upper portion of the rectum at the promontory of the sacrum. Colostomy for obstruction in cecum, later a second colostomy of the transverse colon in the median line, because of a giant colon; third opera-*

tion, resection through abdomen. On account of the condition of the patient, no attempt at restoration of the continuity of the bowel. June, 1906, *one year and nine months, well.*

Clinically, this case is of interest because of the difficulty of diagnosis. The patient was a white female, thirty-five years of age. When admitted to the hospital with symptoms of two weeks' obstruction, her condition was so critical that nothing was done, except a colostomy of the cecum under cocaine anesthesia.

FIG. 11.—Case 3. Peritoneal surface of resected tumor and gut, showing stricture in Case 3.

This patient gave a history of a palpable tumor in the region of the right kidney for many years; this tumor had been palpated by her physician, Dr. Simmonds, of Hagerstown. During the last six months she has had a few attacks suggesting obstruction. The present attack of two weeks' duration has not been complete from the onset; now and then gas and fecal matter had passed.

The distention of the abdomen was so great that the tumor in the region of the right kidney could not be palpated; peristaltic action could be made out. As the distention in the region of the cecum was unusually marked, and as rectal examination was negative, the possibility of a tumor in the region of the kidney as the cause of obstruction had to be considered. For this reason the cecum was exposed. The peritoneal cavity contained bloody fluid; the cecum was enormously distended with thick walls.

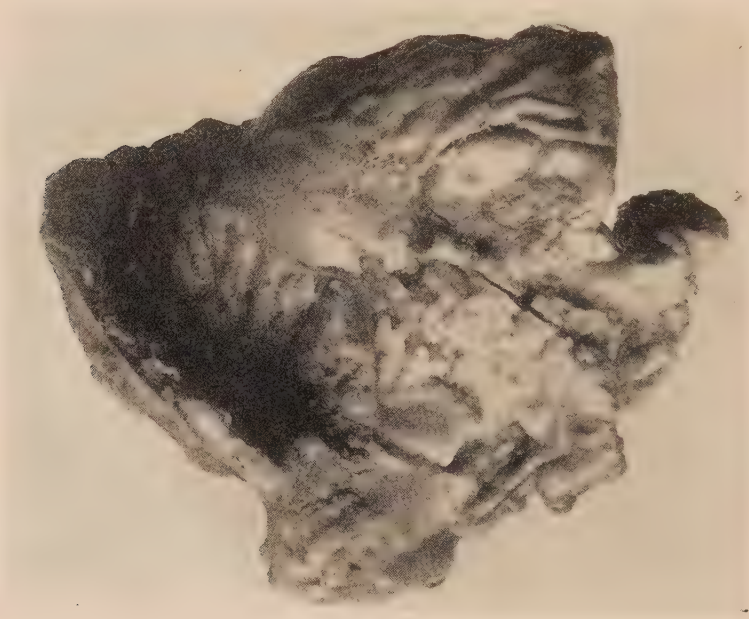


FIG. 12.—Case. 3. Photograph of Kaiserling specimen, showing mucous membrane surface.

The condition of the patient did not allow further abdominal exploration.

About three weeks later, the obstruction having been relieved, the abdomen was opened in the median line; the ascending transverse and descending colon were enormously distended; both kidneys were enlarged, due to a general cystic disease; the right kidney was larger; a hard tumor could be palpated in the rectum,

at the promontory of the sacrum. This tumor explained the obstruction, and was undoubtedly a carcinoma. The distended condition of the large intestine and the still weakened state of the patient contraindicated an attempt at resection. For this reason an enterostomy was performed on the upper portion of the sigmoid in the lower portion of the median wound.

FIG. 13.—Case 3. Diagram of anatomical relations after operation in Case 3. U, umbilicus, colostomy above; Y, closed end of colon; X, closed end of rectum, to which there is an adherent loop of small intestine.

The third operation was performed four weeks later. The patient's general condition had very much improved. The details of the operation correspond to that described in Case 2, except that, on account of the lower position of the tumor, the rectum was removed down to the lowest plane of its peritoneal covering in the pelvis (Fig. 10). The opening in the end of the rectum

and colon were closed by invagination, because the operator was doubtful whether a suture should be attempted. With my more recent experience, I should, at the present time, make the suture.

Pathology. The tumor is an adenocarcinoma; it has not infiltrated through the rectal wall; one gland in the adjacent mesentery showed metastasis. (See Figs. 11 and 12.)

Postoperative Notes. The patient had no complications, but it is interesting to note that now and then a little gas and fecal matter passed per rectum. It was difficult to explain this, except on the supposition that a loop of small intestine had become adherent to the invaginated end of the rectum and a small pathological anastomosis had formed. Such a condition is a well-recognized postoperative complication, when the operation has been performed in this way. Cases of fatal postoperative obstruction have been reported. Gouillioud and Faysse (loc. cit.) report one such case. The supposition was confirmed. In March, 1905, four months after the last operation, at the request of the patient, I opened her abdomen again, with the hope of restoring the continuity of the large bowel. There was no evidence of recurrence or metastasis. A loop of small intestine, apparently the jejunum, was firmly adherent to the closed end of the rectum deep in the pelvis (Fig. 13). It was so adherent that a complete separation would have injured the integrity of the small intestine so extensively that, without much doubt, resection and suture would have been necessary. In view, therefore, of the possibility of two anastomoses, I did not think it was justifiable at that time to attempt to restore the continuity of the bowel in a patient whose only discomfort was a colostomy.

CANCER OF THE COLON:

WITH SPECIAL REFERENCE TO ITS DIAGNOSIS; TYPES OF OPERATION; METHOD OF AVOIDING FECAL DROWNING.

By WILLY MEYER, M.D.,
NEW YORK CITY.

This article is to deal with cancer of that portion of the large intestine which lies between cecum and sigmoid. (See Fig. 1.) Malignant disease of the rectum and lower portion of the S. romanum, where it is still detectable by means of the sigmoidoscope, as well as of the cecum, which, usually, is more or less recognizable by palpation, will not be considered.

In the portion thus outlined, the sigmoid curvature is most frequently the seat of the disease; next in order of frequency come the two flexures and descending colon, then the transverse, and finally the ascending colon.

The tumor is usually solitary. Only a few cases of multiple occurrence have been recorded.

As regards the stage of life at which the disease is most commonly seen, it may be said that in the majority of cases it occurs after middle age, although it is not infrequently observed in the fourth decade of life, very rarely, however, in patients under thirty years of age.

As to the type of the neoplasm, there is no restriction. We find the infiltrating, medullary growth as well as the more frequent cylinder-celled cancer with glandular structure, and also the constricting scirrhus.

According to the type of tumor the clinical symptoms vary. In the case of an infiltration, the resulting tumor is usually large and readily palpable, sometimes even through a thick abdominal wall. Its tendency to ulceration and bleeding accounts for the

presence of pus and blood in the defecations, and a certain *persistent*, exceedingly fœtid odor of the stools, which is overcome neither by purgatives nor by the use of intestinal antiseptics. In these cases, even in the absence of symptoms of obstruction, the suspicions of patient as well as physician are usually early aroused. Not so in the case of the sharply defined, circular

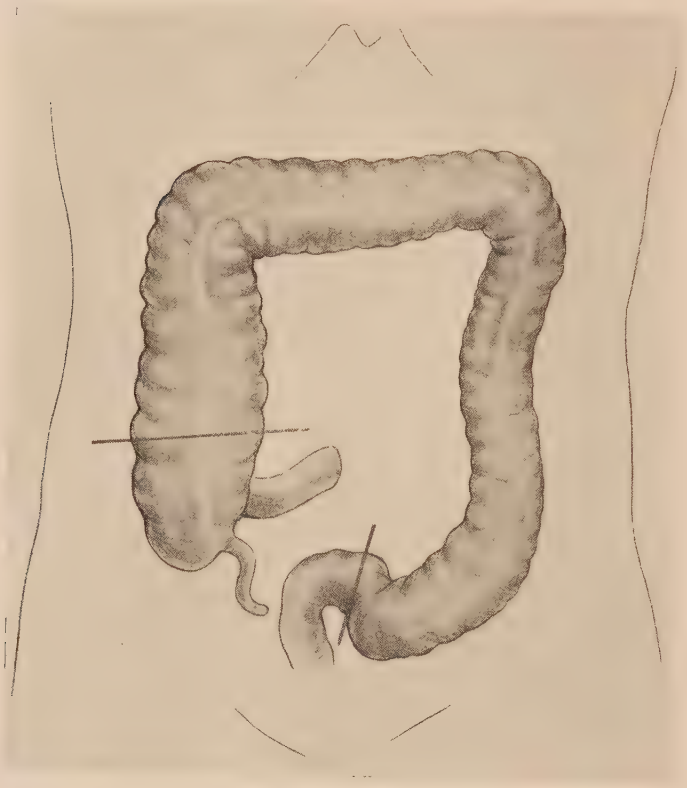


FIG. 1

scirrhus, often surrounding the gut in the shape of a tight, narrow ring. Symptomless almost, and at no time detectable by palpation, it has developed at the hepatic or lienal curvature, or in the colon pelvinum. Suddenly a fruit-pit or some other descending foreign body is arrested in the narrow lumen, or a congestion

is set up by some mechanical irritation of the inner surface of the tumor. Complete or partial intestinal obstruction is the result.

The latency of the development of certain forms of carcinoma, then, is the principal cause of its late—often too late—recognition, here as well as in other parts of the body.

On the other hand, it is necessary that the physician should include the possible presence of this disease in his considerations in the face of obscure intestinal symptoms. It surely occurs oftener than is ordinarily accepted.

Every symptom, therefore, that justifies the suspicion of colonic cancer, and every method that may help to determine the correctness or incorrectness of such a suspicion, must be welcome; all the more so, as the prognosis of carcinoma of the colon is better than that of malignant disease in any other part of the gastro-intestinal tract.

If the well-known trio of *subjective* symptoms—obstinate constipation, occasionally alternating with diarrhœa, without any apparent cause; colicky intestinal pains; and vomiting or nausea—is well developed, the diagnosis of carcinoma of the colon can usually be made, even in the absence of a palpable tumor. But all three of these symptoms are rarely present. One of the most valuable symptoms, according to my personal experience, is that of periodic, not always painful, contraction within the abdomen, noticed by the patient *himself*, always more or less in the same locality, and in later stages, often followed by a gurgling sound, which sometimes is distinctly audible without the use of the stethoscope.

This phenomenon, which properly should be classed under the second of the trio of subjective symptoms, *i. e.*, intestinal colics, is of such great importance that I would give it a special place. I would call it "*subjective* intestinal stiffening," in contradistinction to the "*objective* intestinal stiffening" (Darmsteifung), or tetanic recurrent peristalsis of the gut proximal to the seat of the disease, first described by Nothnagel as a visible and palpable sign.

In one of the cases observed by me in conjunction with other physicians, this "subjective stiffening" of the gut was the only

symptom complained of for eight to ten months, other clinical signs being indistinct. Then, after a fall upon the abdomen, intermittent chills and fever with peritonitic symptoms developed (perforation). A large mass could be felt through the vagina, in the left side of the abdomen. Laparotomy demonstrated an ulcerating, malignant neoplasm of the transverse colon, about the size of a large orange, covered by suppurating omentum. The tumor had sunk down by its weight into the small pelvis and become adherent to the bladder, infiltrating its wall.

Such experiences teach the necessity of eliciting a most careful history from patients with vague abdominal symptoms, and of giving due weight to the same.

Another early subjective symptom of malignant disease of the colon and sigmoid flexure, recently emphasized by Tuttle (*New York Medical Record*, Nov. 4, 1905), is the markedly increased tendency to expel gas and the inability to retain it. Along with this increased passage of gas, early in the disease, there appears in the stool a certain amount of glairy mucus, never coagulated, as in typical mucomembranous colitis. Tuttle further calls attention to the fact that constipation is a late, and not an early, symptom. Frequent desire to go to stool, with no effectual result, according to his experience, is a "striking early symptom of cancer of the colon."

It is self-understood that such complaints being common to many intestinal disorders, are of value only if supported by one or more of the notable subjective or *objective* signs, which latter I will now briefly review.

I. TUMOR.

According to Treves, a tumor can be made out in only 40 per cent. of the cases. Its manifestation affects the prognosis less seriously than is the case in carcinoma of the stomach, where, in many instances, the palpation of a tumor is equal to a "too late" for the surgeon, as far as radical cure is concerned, although, in view of more recent statistics,[1] this general belief would seem

to require modification. Boas' careful personal observations confirm the conclusions of Peters and Calmers,[2] that the degree of malignancy of the various types of carcinoma, especially in the case of carcinoma of the stomach, and their tendency to rapid proliferation, often are more important factors as regards radical cure, than the duration of the disease. In other words, excision of a large, easily palpable tumor of slow development may prove curative, whereas, in a more highly malignant, rapidly growing tumor, operation may prove unavailing, even though it be done shortly after the appearance of the first clinical symptoms.

As stated before, cancer of the colon is usually less virulent than that of the stomach and rectum, as proven by its generally slow development and slight tendency to metastasis. Cases with characteristic cancer symptoms, covering periods of from two to six and sometimes eight years, are on record, and then colectomy was still feasible.

In one of my own cases radically operated upon, a lady aged fifty-seven years, the disease had developed in the course of five years. The tumor, starting at the hepatic flexure, had gradually invaded the entire ascending colon, the strictured canal just allowing a small lead-pencil to pass.

As regards the size of the tumor, this varies between wide limits —from the size of a walnut to that of a child's head. It is usually hard and nodular in consistence, and more or less tender. If situated in the transverse colon, particularly if near the hepatic or lienal curvature, a change of location is often observed.

Careful insufflation of the gut may aid in locating the tumor, and enable us to determine whether it be retroperitoneally or intraperitoneally situated. Great care should be exercised, however, to avoid perforation.

2. METEORISM.

Chronic, circumscribed meteorism is of great assistance in locating the tumor. If it be general, all other clinical signs are, of course, rendered obscure.

3. FREQUENT, VISIBLE AND PALPABLE LOCALIZED PERISTALSIS (NOTHNAGEL'S "DARMSTEIFUNG").

Its presence, often followed by a peculiar gurgling sound, of course, speaks for stricture. It represents an unfailing pathognomonic sign, but, naturally, can be noticed only in emaciated patients. By quickly jerking the respective area of the abdominal wall, the peristaltic wave can be artificially produced, as in gastrectasy due to stricture of the pylorus. (Dr. R. Stein, of New York, has recently called attention to this fact. Article still unpublished.)

4. CHARACTERISTIC FECES.

The stools may be entirely normal in spite of the constricting tumor of the large intestine. Having passed the stricture, the fecal matter is condensed, through absorption of fluid; scybalæ are formed. Blood is found in only 15 to 25 per cent of the cases. The so-called "occult hemorrhage" in the stools is of little value.[3] If pus and blood are present in larger amounts, the differential diagnosis from chronic colitis is not easy. The history of the case, mainly with reference to similar attacks in former years, is here often helpful. Protracted irrigation of the lower end of the bowel by means of a funnel and rectal tube with end-hole and lateral eye—same as used for stomach lavage—may bring down small particles of the ulcerating tumor and thus promptly clear up the diagnosis. Regular examination of the feces is, therefore, imperative in cases of this kind.

5. CAPILLARY ANGIOMATA AND PIGMENTED WARTS IN THE SKIN OF THE ABDOMINAL WALL.

The rather sudden appearance of multiple capillary angiomata and manifold small pigmented spots and flat warts in the skin of the abdominal wall may be interpreted as a symptom of intra-abdominal (colonic) cancer, an observation first made by

S. Pollitzer, of New York, and later by E. Hollender, in the hospital and private practice of James Israel, of Berlin,[4] the correctness of which I have had repeated occasion to verify.

Pollitzer describes this phenomenon, under the name of acanthosis nigricans, in the *Reference Hand-book of the Medical Sciences*, vol. i, p. 51 (William Wood & Co., New York), as a disease of the skin and mucous membrane, characterized by hyperpigmentation and papillary hypertrophy developing in the course of an abdominal cancer.*

The first recorded case of this disease occurred in a patient in Dr. Unna's Clinic for Skin Diseases, Hamburg, and was described by Pollitzer in the *International Atlas for Rare Skin Diseases*, No. 4, 1889.

According to him, the disease usually begins with a slaty or brownish discoloration of the skin of the neck, about the genital organs and the umbilicus. In other cases the first symptoms to attract the patient's attention is the papillary condylomatoid proliferation affecting the mucous membrane of the mouth. Other regions that may be affected are the palmar surfaces of the extremities, the axillæ, and the inframaxillary region, the anal region, and, in women, the vulva and vaginal mucosa. A striking feature is its almost perfect symmetry.

In trying to explain this phenomenon, Pollitzer says: "There is no doubt that the disease is directly dependent on the existence of abdominal cancer, but whether it be a cutaneous manifestation or a peculiar cancer intoxication, or whether it be due to changes induced in the great sympathetic ganglia through the pressure of the tumor on them, or to the combined action of both these causes, is a matter that future investigation must determine."

To the courtesy of Dr. J. Fraenkel, of New York, who has given special attention to segmental innervation, I owe the following explanation of this interesting phenomenon:

"Pigment alterations and pigment anomalies have various causes.

* In 1896, the same disease was described by P. Couilland under the name "Dystrophie papillaire et pigmentaire ou acanthosis nigricans; ses relations avec la carcinose abdominale." (Paris, Georges Carré et C. Naud.)

Congenital hyperpigmentation and constitutional ephelides are usually associated with some altered function of the adrenals. Of distinct pathological character are pigmented wart-like changes in the skin observed in connection with changes of the arterial system.

"Arterial disease of the cranial system sometimes produces a crop of such changes on the face. The changes of the thoracic arterial system produce such marks on the trunk and extremities.

"Chronic intra-abdominal disease, particularly the degeneration of the splanchnic arterial system, produces such trophoneurotic changes in the skin of the abdomen. Their pathogenesis is not absolutely clear, and in the light of the newest knowledge, attributable to one of the following causes:

"1. Some change in the function of the adrenals.

"2. Some change in the function of the semilunar ganglia or splanchnic nerves, which are a part of the adrenal system.

"3. Some change in the structure of peripheral vessels, which are accompanied on their entire course by the so-called chromaffine bodies, which are regarded as a specified type of neural tissue, and related to the histological units of the medullary part of the adrenals.*

" Another group of trophoneurotic changes of the skin, pigmented and vascular nævi, is produced reflexly from a spinal segment which receives altered innervation from a viscus.

" This last-named origin of the changes is particularly suggestive then, when they are distributed somewhat in the area of the segmental innervation. They may be looked upon as a further stage of interference with the segmental function, of which the first is expressed by increased vasomotor and sensory reflexes (reflex hyperesthesias)."

Personally, I consider this skin affection, which is due to trophoneurotic disturbances, an important sign of intra-abdominal cancer. It occurs only in a certain percentage of cases, and after the disease has made some progress. According to a personal

* See also article of same author, "The Relation of the Nervous System to Visceral and Trophic Phenomena," New York Med. Record, April 1, 1905.

communication from Dr. Pollitzer, he has found thirty-six such cases of acanthosis recorded in the literature, and in a decided majority of these, a malignant tumor "in abdomine" was later demonstrated or strongly suspected. Personally, I have observed it four times, and though it appeared in a rather mild type, it nevertheless strongly suggested the condition that has been described as acanthosis nigricans.

Case 1 referred to a lady, fifty-six years of age, with a large distinctly palpable, inoperable malignant tumor of the sigmoid, adherent to the abdominal wall. The skin of the lower anterior portion of the abdomen was studded with these purplish and brownish spots.

Case 2 was that of a colleague, seventy-five years of age, with vague complaints of chronic intestinal disease. He himself pointed out to me the mixed cutaneous crop, not understanding its significance, which had then just been called attention to in the literature. Operation revealed the presence of a carcinoma of the transverse colon, which at no time had been palpable.

In the third case, a glance at the abdomen, over which were scattered numerous purplish spots and flat, wart-like brownish-black excrescences, with innumerable smaller and larger pigmented spots surrounding the anterior wall like a wide girdle, made me place the diagnosis of carcinoma of the colon at the head of the list of possible alternatives, after having listened to the patient's history. Subsequent operation proved this assumption correct. Four months after successful excision of the ascending colon these peculiar, dermatological manifestations had disappeared. Surely, an interesting observation! (Fig. 2.)

The fourth case is still in the hospital, in the service of my colleague. The patient, a woman aged fifty-six years, suffered from constipation for the last three or four years; during the last eighteen months she has had frequent pains across the abdomen. A large, nodular, slightly tender, hard mass is palpable just below the border of the left costal arch; it is movable, and easily detectable on bimanual palpation. The anterior abdominal wall presents many capillary angiomata, smaller and larger

brownish spots, not unlike freckles, and flat, wart-like pigmented skin infiltrations, as shown in the accompanying illustration (Fig. 3).

Catheterization of the ureters proved the left kidney entirely normal, with unimpaired working power. On basis of this string

FIG. 2.—Appearance of skin of abdomen four months after excision of ascending colon. The pathognomonic dermatological manifestations have disappeared.

of symptoms I made the tentative diagnosis of cancer of the splenic flexure and descending colon, although the statement that the sensation of stiffening had never been noticed, and the fact that in carefully ballooning the colon with air the latter organ seemed

Fig. 3.—Showing a mild condition of Acanthosis nigricans. (Case IV. Cancer of pancreas. Secondary infiltrated peritoneal glands.)

to lie in front of the mass, made me somewhat doubtful as to the correctness of this diagnosis. Exploratory incision showed the transverse and descending colon normal. The nodular mass that had been palpated proved to be infiltrated cancerous lymphatic glands in the retroperitoneal space, secondary to a carcinoma of the pancreas.

6. CONTINUOUS LOSS OF WEIGHT AND INCREASING ANÆMIA.

The regular use of the scales in suspicious cases cannot be too strongly urged. If the disease takes a slow course, patients may have their ups and downs, but a *steady* loss of flesh, in conjunction with gradually increasing anæmia and general weakness, not necessarily cachexia, points to the presence of carcinoma.

DIFFERENTIAL DIAGNOSIS.

In cases with a palpable, non-ulcerative tumor, the following conditions come primarily into consideration:

1. Tumor of the kidney, or a floating kidney.
2. Chronic cholecystitis, or hydrops of the gall-bladder.
3. Benign, intracolonic, sessile tumor, usually lipoma or myoma. (See S. B. Ward, *Albany Medical Annals*, January, 1904.)

The latter, according to my experience, may produce the full trio of malignant disease: obstinate constipation; colicky pains, and vomiting or nausea. However, if situated in the transverse colon or in either of the two curvatures, the tumor will be found frequently to change its location to a marked degree; and such *pronounced* mobility then will speak for intracolonic attachment of a benign growth, especially if found in younger patients. The following case well illustrates the point:

Young woman, aged twenty years; typical symptoms; varying position of tumor; laparotomy, May 22, 1901. Sessile growth, with broad base in transverse colon (see Fig. 4), proximal to lineal curvature; resection with end-to-end anastomosis by suture.

Pathological diagnosis, lipoma. Rapid recovery. Re-examination, March, 1906, shows patient in perfect health.

If careful analysis of all symptoms still leaves doubt as to the true nature of the trouble, exploratory laparotomy is in order. In that case the surgeon must, of course, be prepared to add the required operation at the same sitting.

FIG. 4.—Lipoma of transverse colon. Resection with end-to-end anastomosis. Recovery.

TYPES OF OPERATION.

I. Radical Operations.

1. *Ideal.* Operation in one sitting.

(*a*) In case of a circumscribed tumor: resection of the diseased portion with end-to-end anastomosis.

The tension of the sutured ends, the uneven size of the afferent

and efferent portions, with circulatory disturbances and insufficient muscular action, sometimes ulcerations within the former, also the greatly diminished power of resistance of the patient, in combination with the increased virulency of the bacteria inhabiting the colonic segment above the stricture, make this procedure a very risky one.

FIG. 5

(*b*) In case of more extensive involvement of gut: lateral anastomosis* in safe distance from the neoplasm, by means of suture,

* I consider mechanical means for perfecting anastomosis in these cases of grea value in weak patients. In view of the fact that the button may drop into the afferent portion of the gut and then give rise to trouble, McGraw's elastic ligature deserves special attention. I have learned with increasing experience to look upon the use of the elastic ligature as a method that will save many lives When performing such operations, the choice therefore lies for me between needle and thread on one hand and the elastic ligature on the other.

elastic ligature, or Murphy's oblong button (Figs. 5, 6, 7), or end-to-side implantation in case of ileocolostomy (Fig. 8), best with the help of Murphy's ordinary round button, and excision of growth, including the infiltrated mesocolonic glands.

Unfortunately, the majority of patients thus afflicted reach the surgeon in a greatly reduced condition, when they are no longer able to stand this ideal procedure. Personally, I have never had

FIG. 6

the chance to operate upon an early case, every one of my patients presenting either a large, palpable tumor, peritonitis, or symptoms of obstruction with or without ileus.

2. *Operation of Choice.* Same as 1, but done in two sittings as illustrated by the following personal case:

Woman, aged fifty-seven years; bowel trouble for last five years; first, intermittent colicky pains and sensation of a sore

spot in right side of abdomen, then attacks of nausea, but no vomiting; later, subjective intestinal stiffening; treated for gall-stones for years. Examination October, 1905, reveals localized peristalsis; tumor indistinct; pronounced typical eruption of skin in waist-line, anteriorly; very anemic; hemoglobin, 40. November, 1905, laparotomy through right rectus; cancer of ascending colon; gall-bladder normal; ileocolostomy with elastic ligature, ten

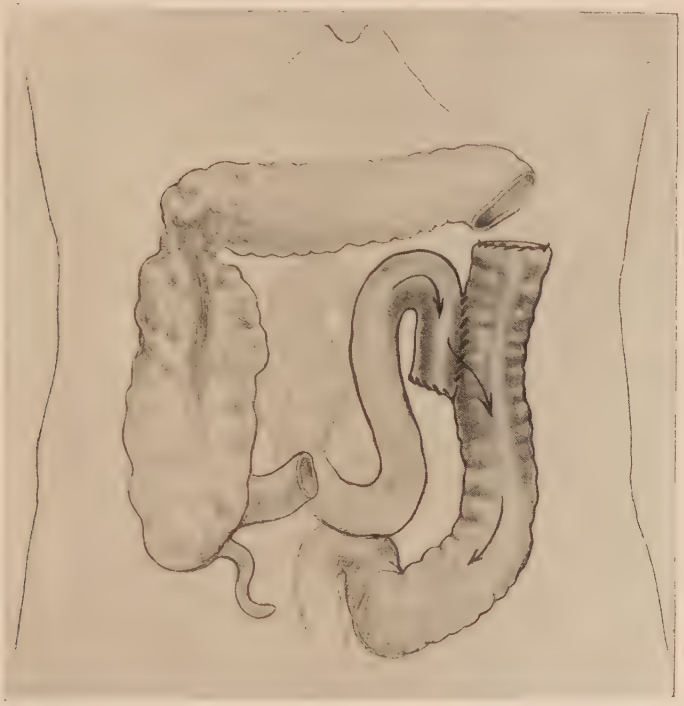


FIG. 7

inches above ileocecal valve to distal portion of transverse colon; closure. Five weeks later, December, 1905, with patient's general condition much improved and bowels working regularly, median incision; tying of mesocolon; typical excision of cecum and ascending colon from a point about five inches above ileocecal valve to middle of transverse colon; application of crushing forceps to colon and ileum near anastomosis; ligature; purse-string suture,

inverting stumps; continuous suture on top; no drainage. Uninterrupted recovery. May, 1906, perfect condition; patient has gained thirty-five pounds.

The excised portion of colon showed pronounced stricture, just permitting the passage of a small lead pencil. (See Fig. 9.) In spite of this there had never been obstruction to defecation, but stools had not been formed within last four years; lately diarrhœa, off and on, with particles of blood.

FIG. 8

3. Temporary, partial eventration of portion of gut invaded by the tumor, after ligation of the respective piece of the mesocolon, inclusive of diseased glands; closure of wound (Fig. 10), followed thirty-six to seventy-two hours later by amputation of diseased portion about one-half to one inch above surface of abdomen,

with Paquelin, thus establishing a temporary artificial anus. Two weeks later, application of clamp, followed by typical closure of artificial anus (Fig. 11), being the so-called "Vorlagerungs Methode" of von Mikulicz, who reported eleven recoveries in twelve operations.[5]

FIG. 9.—Excised lowest portion of ileum with cecum and ascending colon; the latter the seat of the malignant stricture. A flap of tissues grown into the lumen of the gut has been raised in order to show pronounced stricture.

4. In cases of incomplete or complete intestinal obstruction of long duration, the weak condition of the patient and the far-

reaching œdema of the distended afferent part of the colon forbid all of the foregoing operations. Primary enterostomy remains the patient's only hope of relief, to begin with. A series of opera-

FIGS. 10 and 11

tions is necessary to effect a possible cure; of course, interruption of this series, waiving absolute reclosure of the intestinal tract, may become necessary after any step.

The series of operations are:

(*a*) Enterostomy, which may be done under cocaine and in slight Trendelenburg's posture—if time permit, according to Witzel's or Kader's method.

(*b*) After sufficient recovery, lateral anastomosis (under thorough inspection of local condition of the gut), plus immediate excision, or the latter done at a third sitting.

(*c*) Closure of enterostomy wound. If a water-tight fistula was established, removal of the tube suffices.

II. Palliative Operations.

1. Lateral anastomosis in sufficient distance from growth; closure of abdomen.

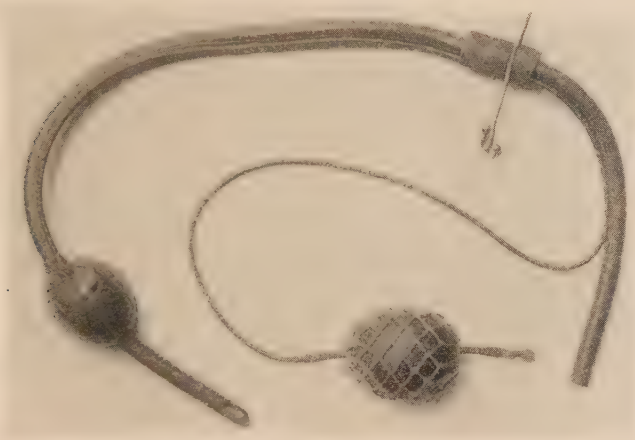


FIG. 12.—Kausch's original œsophageal narcosis tube.

2. Establishment of artificial anus. In the cases that here come into consideration the artificial anus would best be established in the cecal region or in the lower end of the descending colon.

3. In cases with pronounced meteorism and fecal vomiting, enterostomy will, of course, have to be the first step resorted to, other operations to follow in accordance with the conditions found.

It is, naturally, of the utmost importance to the patient, and a great satisfaction to the surgeon, no matter whether he be doing

radical or palliative work, to avoid the kind of seriatim operating described above.

The duration of the complete or incomplete obstruction as well as the age and general condition of the patient, must guide the operator in determining what had best be done in the given case. Frequently, primary enterostomy will be found to promise best results. If a more aggressive procedure seem advisable, *fecal drowning* or aspiration of vomit into the bronchial tubes has, until recently, been the patient's greatest source of danger, having caused many deaths. It would occur in spite of preliminary lavage and the use of a stomach-tube during or at the completion of the operation.

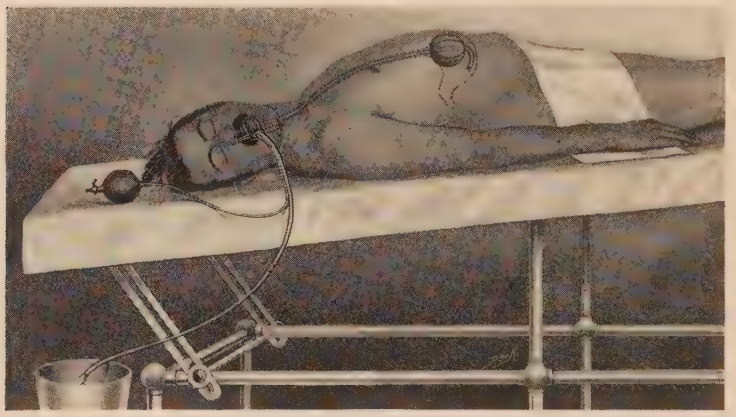


FIG. 13.—The œsophageal narcosis tube, slightly modified by author, in place during operation for intestinal obstruction. The lower bulb, properly distended, hugs the cardia. It must not be pulled into the œsophagus. The proper position of the tube has to be controlled by an assistant during the entire course of the operation.

However, this danger has been overcome since the advent of Kausch's œsophageal narcosis tube. It is constructed on the principle of Trendelenburg's tampon-cannula for the trachea, as follows:

An ordinary soft rubber stomach-tube is made to pass through a rubber balloon, the latter being 7 centimeters in diameter when fully inflated, and is securely fastened around the tube at both

points of passage, the lower being two inches above the eye at the end of the tube (Fig. 12). Emerging together with the stomach-tube from the upper end of this balloon, and passing along the same, is a thin rubber tube, which, a few inches from the outer end of the stomach tube, separates from the same to enter another bulb of exactly the same size as the lower one, thus forming the connection between the two balloons at either end of the apparatus.

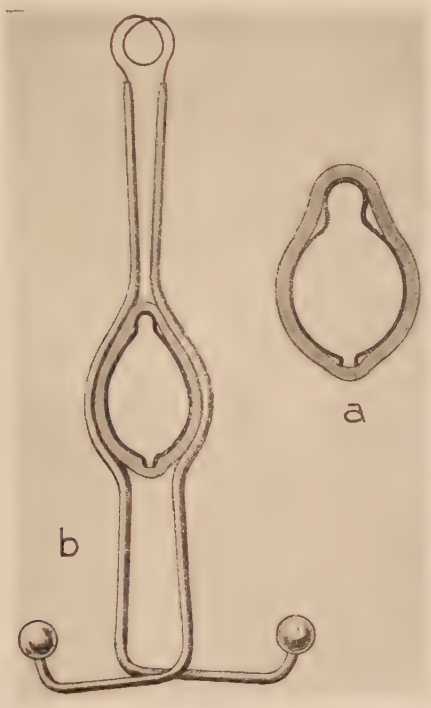
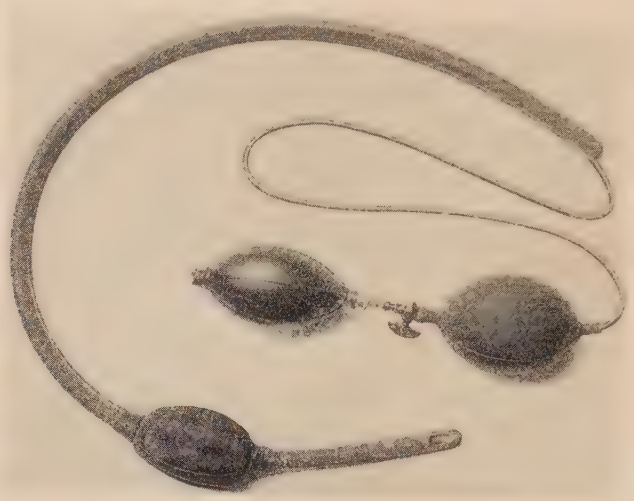


FIG. 14.—Metal capsule and spring; the former (*a*), fixating the tube, prevents compression of the apparatus by the patient's teeth; the latter (*b*) secures the proper position of the distened bulb at the cardia, as shown in Fig. 13.

From the opposite side of the outer balloon a small piece of thin tube is made to project for the purpose of inflation, which may be done by means of a hand syringe. Before beginning the operation, this apparatus, with the lower bulb pressed empty and well anointed, is easily introduced into the stomach. Then the bulbs

A



B

FIG. 15.—*A*, the œsophageal narcosis tube, slightly modified, with bulbs collapsed. Metal capsule, preventing compression by patient's teeth, slipped off. *B*, the œsophageal narcosis tube with bulbs inflated; the feeder detached.

are distended and the small projecting tube is plugged or clamped. The narcosis tube is pulled upward until it meets resistance, which means that the lower bulb presses against the cardial opening, thus rendering it impossible for any stomach contents to pass through the cardia; every drop has to find exit through the tube (Fig. 13). Care must be exercised, of course, to keep the balloons well inflated, but as the outer is of exactly the same size as the one placed internally, the former furnishes an exact index to the condition of the latter; if insufficiently distended and too much traction is employed, it is plain that the lower bulb might be pulled into the œsophagus. While the tube is *in situ*, the saliva cannot be swallowed; the patient's head should therefore be turned sideways and the pharynx wiped out from time to time. A slight Trendelenburg posture facilitates the exit of the saliva.

To prevent compression of the apparatus by the patient's teeth, a metal capsule resting on two springs is slipped over the same, the tube lying in a groove provided for it (Fig. 14, *a* and *b*). The instrument remains undisturbed until the patient has fully recovered after anesthesia. If it is properly placed and fastened, all of the fluid of the intestinal tract which continually regurgitates into the stomach during the operation is carried through the tube into a pail beneath the operating table. Hence, the evacuation of the intestinal contents through multiple transverse incisions into the gut, with subsequent suture, which usually becomes imperative in order to accomplish reduction of the greatly distended coils after eventration, is rendered unnecessary, and consequently the danger of infection is materially reduced.

Kausch's œsophageal narcosis tube surely represents a most important addition to our instrumentarium for the treatment of colonic cancer and other cases of intestinal obstructions, and should find a wide field of usefulness.* It is the only apparatus at our disposal for the purpose stated, and is perfectly safe.

* The apparatus, slightly modified, may be had of Messrs. Tiemann & Co., 107 Park Row, New York. (Fig. 15, *a* and *b*.)

Kausch has used the device in three cases with perfect success.[6] I have had no occasion so far to test it.

Personally, I have operated upon eleven cases of cancer of the colon, in which the tumor was located within the limits defined by this paper. They are, briefly, as follows:

Case 1.—Female, aged thirty-three years; cancer of hepatic curvature, with multiple metastases in ascending and transverse colon. Colocolostomy in July, 1888; uninterrupted recovery. Patient in excellent condition nine months later; had gained thirty-six pounds in weight; presented before Surgical Section of New York Academy of Medicine. The patient then left for Europe, so that further operating here, as intended, became impossible. Primary ileocolostomy and resection of the diseased portion of the gut at a second sitting, I now think, would have been more advisable in this case.

As far as I have been able to determine from the literature, this was the first case of colocolostomy done for malignant stricture. (See *N. Y. Med. Record*, November 24, 1888).

Case 2.—Male, forty-six years old; cancer of hepatic curvature, involving ascending and major part of transverse colon. Ileocolostomy, end to side, Murphy's round button, February, 1899, with excision at the same time.

At first, satisfactory recovery; then, suddenly, change for the worse, after severe attack of coughing; on changing dressing, ten days after operation, it was seen that wound had burst open again; peritonitis; death two days later. Layer sutures of catgut had been used for closing wound. Since this experience I have always used through-and-through silk sutures for closing the abdomen in the male.

Case 3.—Male, sixty-eight years old; cancer of lienal curvature; intestinal obstruction; ileus. Ileosigmoidostomy, October, 1902; death twenty-four hours later, from aspiration of fecal vomit and pneumonia. Primary enterostomy or cecostomy would probably have been the wiser procedure, but artificial opening was refused by family.

Case 4.—Male, forty-six years old; cancer of transverse colon

and hepatic curvature; very large tumor; fever; subacute peritonitis, due to perforation. Ileocolostomy; death six days later as a result of peritonitis.

Case 5.—Male, sixty-five years old; cancer of ascending colon and hepatic curvature; intestinal obstruction for eight days; peritonitis; relief asked for, but enterostomy refused. Therefore, exploratory incision; afferent part of intestine enormously enlarged; probably distention ulcerations, for gut bursts despite most careful handling; closure of rent; multiple incision of eventrated coils; reduction; suture. Entire operation done in slight Trendelenburg posture, preceded as well as followed by stomach irrigation. At the moment that patient was lifted from stretcher into his bed, massive vomitus with aspiration occurred, causing instant death.

Case 6.—Female, fifty-seven years old; cancer of hepatic curvature, involving ascending colon. Ileocolostomy, November, 1905. Excision of ascending and half of transverse colon five weeks later; good recovery; patient well at the present time. (See above.)

Cases 7 to 11.—All were cancer of upper part of sigmoid curvature, with symptoms of complete or partial intestinal obstruction; pronounced meteorism, or symptoms of ileus. Treatment, small median or lateral exploratory incision on outer side of left rectus muscle, for the purpose of locating suspected tumor, followed by typical oblique incision parallel to Poupart's ligament for colostomy (or, latter incision made at once, in order to avoid two cuts); artificial anus in lower end of descending colon, with spur formation. Three recoveries, two deaths.

While the results in the foregoing cases are not particularly encouraging, it must be remembered, that all, with exception of Case 6, were in a more or less hopeless condition when they came for treatment.

Briefly restated, the main points of the foregoing remarks are:

1. The great importance, as well as the difficulty, of early diagnosis and timely operation in carcinoma of the colon, particularly in view of its comparatively favorable prognosis.

2. The necessity of most careful study and consideration of the often obscure symptoms of this trouble.

3. The great diagnostic value of—

(*a*) The so-called "subjective" as well as "objective intestinal stiffening" or tetanic recurrent peristalsis of the gut proximal to the seat of the disease.

(*b*) The multiple capillary angiomata in combination with the more significant small pigmented warts and spots that are frequently seen to appear in the skin of the abdominal wall. The latter may be accepted as an almost unfailing pathognomonic sign, provided the history and palpation point to colonic disease.

4. Radical operation, based upon early diagnosis, may well be successfully performed in patients up to sixty years of age and older, provided their general condition is good.

5. In old and weak patients, timely palliative work by means of a lateral anastomosis will enable us to circumnavigate the establishment of the always objectionable artificial anus, and make unnecessary the seriatim operating, which is unavoidable if the patients reach the surgeon with pronounced tympanites and ileus.

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DISCUSSION ON THE PAPERS OF DRS. TRENDELENBURG, ARMSTRONG, MAYO, MEYER, McARTHUR, ESTES, CABOT, HEARN, PILCHER, AND BLOODGOOD

Dr. N. B. Carson, of St. Louis.

I wish to present a specimen bearing on the subject of the paper read by Dr. Cabot, which demonstrates the point made by him that foreign bodies may enter the alimentary canal, pass through the entire length of the canal until they reach the lower end of the bowel and there produce results.

This is a small piece of the breast bone of a quail. The patient suffered from complete intestinal obstruction. Her condition seemed unfavorable for operation, consequently it was neither urged nor advised. But the members of the family and the patient herself insisted upon an operation being undertaken, with the hope that possibly a good result might follow.

On opening the abdomen I found the seat of the obstruction to be in the large intestine, and in passing my gloved finger along the lower end of the colon just where the colon becomes the rectum it met with a sharp body, which passed through the glove and caught in it and held it. I passed a forceps and removed the portion of bone which I show you and which had resulted in a complete obstruction of the bowel at this point, followed by perforations and general peritonitis, from which the patient died. This case illustrates how complete an obstruction may take place from a small foreign body. There is no doubt that this body in passing through the alimentary canal produced more or less injury, but lodged finally at this point, where it resulted in infection, and which caused the complete obstruction of the bowel just as it tipped over the brim of the pelvis.

Dr. Joseph Ransohoff, of Cincinnati.

I do not know whether it is customary to discuss a paper that has been presented by an invited guest or not. I have nothing whatever to say regarding the details of the operation described by Professor Trendelenburg; but I have in one case tried to increase the size of the bladder. The greatest difficulty, of course, in these cases of ectopy is to get continence; but another difficulty is to secure enlargement of the bladder. Everyone knows that in these cases by bulging the posterior wall of the bladder, the bladder can be pushed back into the abdomen for a considerable distance. In one of my cases, that of an adult, I succeeded in increasing the size of the bladder by making a laparotomy

before doing anything else, getting the bladder, and sewing it up to the anterior wall of the abdomen as well as possible and getting a pocket under the abdominal wall. I increased the size of the bladder and reduced the size of the hernial aperture through which the posterior wall protruded. I did not succeed in getting a complete cure in this case, but the bladder was larger and contained more by the device for avoiding pressure than it formerly did.

I offer this as a suggestion, believing that it is a new one.

I rise more particularly to move that a vote of thanks be given by the Association to Professor Trendelenburg for his exceedingly courteous reply to the invitation and for the very interesting paper he has presented to us.

Dr. W. W. Keen, of Philadelphia.

I should like to make a few remarks in reference to the paper of Professor Trendelenburg and to ask two or three questions.

His remarks in regard to moulding the infantile pelvis so as to approximate the margins of the pubic bones have suggested to me this question: It would answer very well with boys, but in the case of girls the question arises whether it has been tried sufficiently long for such patients to have reached the childbearing age, and if so whether it has produced a serious deformity of the pelvis from the obstetrical point of view.

In the next place, does the loosening of the ilium about the sacroiliac synchondrosis impair to any degree the stability of the walk of the patient? I do not know to what extent this procedure was carried, but if the bones were far separated, it would seem to me it might impair the ability to walk.

In the third place, I would like to ask whether, if this impairment does occur, it would not be possible by making a division of both the horizontal and descending rami of the pubes to approximate the two margins of the pubic opening to such a degree as to get all the desired effect which he wishes, and yet, at the same time, not interfere with the stability of the walking of the patient.

I would like also to call attention to one case of my own which I think shows very remarkably and in the most encouraging manner the ability of the rectum to answer as a bladder. The case is reported at length in my book on "The Surgical Complications and Sequels of Typhoid Fever." It was a patient who, after thirteen operations by a colleague and myself, finally, in 1876, had the following operation done. Her husband had died of typhoid fever. She had nursed him and contracted the disease. During the fever large vesicovaginal and rectovaginal fistulæ developed and persisted even after repeated opera-

tions to close them. Accordingly, I finally dissected out her urethra and closed the vulva entirely, after, of course, explaining to her what would be the result of it. She was well advanced toward the change of life and was not very well favored, and had not, therefore, a very remarkably good prospect of a possible second marriage; and I explained to her what the condition of affairs would be for the future. She accepted the operation, and I closed her vagina entirely, having, as I have already said, resected the urethra. In consequence of that, the menstrual flow, you observe, passed through from the vagina into the rectum through the rectovaginal fistula, and all of the urine passed through the vesicovaginal fistula at first into the vagina, then through the rectovaginal fistula into the rectum. For twenty-two years the history of this woman was known to me. About fifteen years after the operation she came to me complaining of difficulty of micturition. This I found to be due to a small calculus that had formed in the vagina and had acted like a ball-valve, preventing the urine from finding its way into the rectum. It was easily crushed by a curved hemostatic forceps introduced through the anus. The rectum in this woman's case for twenty-two years acted as a bladder and for the ordinary fecal contents of the rectum and as a receptacle for menstrual fluid for a few years. She rose once or twice during the night, but never had any trouble or irritation, and there was never the slightest indication of an ascending irritation or inflammation through the ureters up into the kidneys.

Of course, where a portion of the bladder is resected and transplanted into the rectum, as has been done by a number of surgeons, notably in this country by Van Hook, there have been a number of cases in which ascending infection has followed, but in this case there was none whatever. It is certainly encouraging to know that for at least twenty-two years the rectum served its purpose perfectly.

In reference to the other papers on the removal of various tumors and especially carcinomata of the rectum, I should like to call attention for a moment to a technique which I introduced some years ago and have followed with great advantage. First, I have done a preliminary colostomy. I prefer decidedly an inguinal anus to a sacral anus, because it is so much more readily kept clean and because by no possibility can a bandage be so applied to a sacral anus so as to produce pressure that is perfectly bearable and not keep the contents of the rectum within the bowel; whereas a bandage around the abdomen can be tightly applied with perfect ease. In the next place, I have closed absolutely the lower end of the rectum, so that there is no opening in the perineum whatever. Through the colostomy opening, of course the fecal contents from above flow out through one opening, and the slight mucus which

accumulates between the colostomy opening and the closed lower end of the rectum will find its way by reverse peristalsis also through the other opening.

Dr. Mayo referred to the point that before operation we do not know how extensive the disease is. If the upper border of the disease is beyond the reach of the finger, I have utilized the colostomy opening by inserting a proctoscope into the lower end of it, and have thus inspected the mucous membrane of the bowel perfectly through the bowel as well as investigating by the finger the external surface of the lower portion of the bowel at the time of operation. Dr. Taylor is cognizant of two cases of resection of the rectum in which at least 25 to 35 cm. were removed, in which the diagnosis of carcinoma was thoroughly established, not only by microscopic examination, but by clinical examination in one case by such competent observers as Weir, of New York, and Sinkler and J. C. Wilson, of Philadelphia. Both of these patients are alive today, after fourteen years. One of them rides on horseback a great deal. The other one is a merchant who attends to his ordinary business, and in neither of these cases would anybody know they had an inguinal anus.

Dr. Maurice H. Richardson, of Boston.

If I had known the subject of our President's interesting and valuable address I should have looked up similar cases of my own, of which I have had a small number. In the aggregate there are doubtless many.

The occurrence of benign and malignant growths in the same patient is not uncommon. The malignant degeneration of benign tumors is, in my experience, seen often enough to make one suspicious of the apparently benign growths, especially in the breast and ovary. I can recall a few cases in which two different forms of malignancy have existed in the same patient, one form in the breast and an entirely different form in the uterus. In these cases I refer to tumors, diagnosticated carefully, both macroscopically and microscopically. A very peculiar case was that of fibrosarcoma in an extensive scar following extirpation of the rectum for adenocarcinoma.

The tendency on the part of surgeons has been to rely too much upon others for their diagnoses. The surgeon should not only be his own diagnostician in surgical diseases formerly regarded as purely medical, like appendicitis and gallstones, but he should be able to recognize at once such diseases as typhoid fever and pneumonia. In surgical cases he has always, of course, based his operations upon his own opinion; but when he has invaded fields hitherto exclusively medical, he has looked upon a medical opinion as final. Not that he should disregard medi-

cal opinion—far from it; but he should study from the point of view of surgery all cases in which he is likely to operate. He should make his diagnosis and prognosis himself, and he should study especially the connection between the symptoms at the bedside and the pathological findings at the operating-table. The greatest satisfaction, pleasure, and interest in surgical work are in the diagnosis, with the operative demonstration of its truth or error and its inestimable value to the patient.

With reference to indications and contraindications for operation, it must be remembered that we do not see the cases that we are discussing. If the patient was before us, we should doubtless agree as to the wisdom or the folly of operation. At the bedside I have found agreement over questions of treatment about which at the Society discussion there has been disagreement. I believe that in cases of infiltrating cancer we should not try to operate on the lower bowel—or, for that matter, on any part of the intestine, large or small.

I have seen two cases of intussusception caused by tumors of the internal wall of the cecum. In one, the tumor—a lipoma—was caught in the peristalsis of the colon and a very extensive invagination was produced. Operation was of no avail. In a second case I thought the tumor fecal. Dr. Mixter later operated for acute obstruction and found an intussusception caused by the grasping and dragging of the tumor by the intestine. This patient recovered.

A condition not referred to by the President is idiopathic dilatation of the colon, as described by Fitz. I recall three cases in which grave conditions have resulted—in one a complete volvulus. Resection of the enlarged coil was successful to a greater or less extent in relieving symptoms.

Intestinal actinomycosis has interested me greatly, for in several instances it has proved to be the real cause of conditions supposed to be malignant. The resemblance to cancer is sometimes extraordinary, especially before the formation of superficial abscess or sinus.

With reference to gangrene from interference with the intestinal circulation, there is, I think, no danger of this complication in resection and suture, unless the mesentery is stripped from the opposing ends for an inch or more.

Dr. William B. Coley, of New York.

In regard to the President's address, I remember two cases illustrating the duality of carcinoma and sarcoma in the same patients. The first case, which was reported to the New York Surgical Society about eight years ago, was one of typical carcinoma both clinically and microscopically of the breast in a woman, aged forty-five years, who was

operated on twice, I myself doing the second operation. Three months after the second operation a tumor developed in the submaxillary gland. The supraclavicular and cervical glands were both affected. It grew rapidly and was about the size of an English walnut when I removed it. It was examined microscopically by two or three pathologists who pronounced it non-malignant, although it had the aspects of malignant disease and I believed it to be sarcoma clinically. It recurred in three weeks thereafter. I did the second operation and expressed the firm conviction that it was sarcoma, and after a careful microscopic examination by Dr. B. H. Buxton and Dr. E. K. Dunhaml it was pronounced a round-cell sarcoma. It grew rapidly. A photograph of this case was published in the *Annals of Surgery*. In about three months the tumor had attained the size of two fists and caused death shortly after.

The second case was one of very extensive sarcoma of the abdominal wall, operated by Dr. Chas. McBurney and Dr. George Tuttle, at the Roosevelt Hospital, eleven years ago. The patient came to me two years ago for typical carcinoma of the breast, which I removed, and a careful pathological examination verified the diagnosis.

These cases, together with a considerable number of similar cases, coincide with those which have been related by our President, in which carcinoma and sarcoma have occurred in the same patients or in members of the same family, with hereditary cancer tendencies. There are undoubtedly groups of cases like these in which there has been transmitted a tendency to carcinoma and sarcoma, which types seem to interchange indiscriminately. There is reason for believing that the cause of cancer is much the same whether we have carcinoma or sarcoma to deal with. It is still a question, however, whether the micro-organism is one of a single type or of different types, like the malarial organism, in which there is a slightly varying type, the organism causing in one individual carcinoma and in the other sarcoma. That cancer is due to some form of micro-organism I am fully convinced.

Dr. C. B. G. de Nancrede, of Ann Arbor, Michigan.

In reference to your address, Mr. President, I should like to say that three years ago I removed a breast for carcinoma, and the report came from our professor of pathology that it was carcinoma. One of my assistants, in amusing himself with the growth, found, to his surprise, typical sarcomatous tissue, as he thought. He submitted it to the pathologist and said it was undoubtedly sarcoma. The pathologist said it could not be sarcoma and asked him where he got it. He replied, "I got it from the breast which Dr. de Nancrède dissected and which you pronounced carcinomatous." The pathologist again said that it must be a mistake; that he had got hold of the wrong specimen. He

worked it over, however, and finally admitted that there were evidences of both sarcomatous tissue and epitheliomatous malignant tissue in that breast.

There are two other cases I have had, but I am not sure about it, where this duality existed. The specimens in these cases, however, were not examined by as expert men as Professor Warthin.

In regard to the difficulty of deciding sometimes whether we are dealing with a growth that is inflammatory or neoplastic, I will say that I am in the habit of deciding that in from seven to nine minutes by frozen section.

Dr. Roswell Park, of Buffalo.

There are two or three things I wish to speak of in connection with the papers that have been read, and particularly with regard to a suggestion I made recently, although I have not had an opportunity to carry it out in cases of ectopia of the bladder; namely, a modification of the Maydl principle by transplanting both the ureters into the appendix. Of course the cases that will permit of doing that would be quite unusual, but it is a suggestion that might be carried out. I have had it in mind in a case on which I expect to operate in a few days of inoperable cancer of the bladder. The bladder, the urethra, and rectum are involved, and the woman is suffering terribly. The case has now reached such a desperate point that I have thought the suggestion of transplanting the ureters into the appendix might be carried out.

The other point I wish to speak of is an unexpected sequel of colostomy, in an extreme case of tuberculous ulceration of the rectum. I made a colostomy for physiological rest of the rectum. I lost track of the patient for two or three years, and then I was asked to see him again, when I found an unexpected condition of affairs. He came to me in a horrible condition. I divested him of the apparatus he was wearing, and there came out through the colostomy opening about fifteen inches by measurement of the prolapsed colon. It simply fell out and dropped down alongside of the pelvis and thigh. I had not conceived it possible that there could be such a degree of mobility of prolapsed colon after such an operation. It was the most extreme case of the kind I have ever seen. We frequently see minor degrees of prolapse of this kind, but such an unrolling of the colon as that I had not supposed to be possible, and I would like to put it on record.

Dr. Nathan Jacobson, of Syracuse, New York.

There seems to be a disposition in the discussion this morning to favor the removal of carcinoma of the rectum by the combined method rather than by the sacral route. My experience with the latter has

been so satisfactory that I am hardly prepared to abandon it as an operative procedure. Personally, I have not preceded my operations by colostomy. I have operated usually by the modified method suggested by Bardenheuer. As to the Kraske operation, I have opened up the peritoneum freely, have gone exceedingly high through this route, and my operations have terminated satisfactorily. I have one patient living now who was operated on over twelve years ago, another nine years ago. I presented the specimen from the latter case, an extensive carcinoma of the rectum, at the meeting of the Buffalo Academy of Medicine. In this case about six inches of the rectum was resected. As I have said, this was about nine years ago, and the man is still living. He weighs fifty pounds more than he did at the time of operation.

In another case, that of a woman, operated five years ago, I resected a good share of the vagina with the rectum. In none of these cases have we a fecal fistula. My experience has been that if a free incision is made in the posterior wall of the rectum at the time of the operation and for the time being the discharge of feces is established through this posterior opening, you save the line of union between the anal stump and the proximal end of the intestinal tube. If this is not done the stitches are apt to tear away and you have a large fecal fistula, possibly an artificial anus. I look upon this as an essential feature in the operation. I must say that until I obtain poorer results than I have as yet secured I shall continue to favor the excision of the rectum by the sacral route.

Dr. A. G. Gerster, of New York.

I must join in the expressions just heard from my colleague in saying that although we cannot deny the advantages of the combined method in many cases of highly situated carcinoma, in a locality where rectum and sigmoid flexure join, especially in the female, the perineal route has great advantages. In the male sex, if the preliminary steps are carried out properly, this method is excellent and yields good results.

I would not subscribe to the statement of one of the discussers of the subject, who said that a sacral anus or perineal anus, if I may use that term, has great disadvantages as compared with an abdominal artificia anus.

I believe that the well-known method of Gersuny practised by us at Mt. Sinai Hospital as a routine procedure, consisting of twisting the lower end of the stump of the gut to the extent of three-quarters of a circle, sometimes to a perfect circle, deserves warm commendation. The amount of resistance is tested by the introduction of the finger. By adding this to the resection we gain resistance enough finally resulting in an ampullar dilatation of the lower end of the gut, simulating a

normal condition of the rectal pouch. Of course, so much continence we can never accomplish and gain as is maintained by the normal sphincter; but by regulating the patient's diet, by seeing to it that the fecal column be solid, we can command the bowels to move once a day, complete evacuation of the bowel taking place as a rule. By the method I have mentioned, the cylinder of the rectum is converted into a rifle table, and this twisted folding of the rectal wall is the thing that offers resistance to the escape of solid feces.

As regards the rapidity of the relapse following the removal of carcinoma of the rectum, that does not depend upon the element of a thorough operation alone. It depends on another equally important factor, and that is the virulency of the elements of the tumor. We know that this factor is of the utmost importance in the prognosis; that sometimes a rather incomplete operation is followed by an excellent result; while in other cases the most radical and thorough operation does not yield a good result.

Since several of the speakers have reported cases in connection with the discussion of these papers, I hope I may be permitted to bring forward and put on record two cases of my own, one of which has been published in my book. This patient was operated on in 1884, eleven inches of the rectum having been removed for carcinoma, the diagnosis being confirmed by the pathological examination. Two local relapses followed, for which the patient was operated. The man is well today.

Another patient was operated on seventeen years ago. In his case thirteen or fourteen inches of the rectum were removed. He is living today.

In these two cases the good results were not due to the operation alone, but largely to the fact, in my judgment, that the tumor was not very malignant.

Mr. Charles A. Ballance, of London, England (by invitation).

I deem it a great honor to be asked to take part in this discussion. There are so many points which occur to me that I think it would be wise if I simply deal with one, and if I may be permitted, I will speak of the paper which was presented by the President. The question he has raised as to the duality of cancer can be best explained by an appreciation of the intimate pathology of that disease. I am one of those who believe that ere long we shall be able to establish the fact that sarcoma and carcinoma are due to a microparasite. And it is not difficult to understand that sarcoma and carcinoma may occur in different members of one family or even in the same individual, if we remember that admirable address which the late Sir James Paget gave

on this subject. He showed that different kinds of galls are produced by the same insect, and the difference in the class depends upon the different site or position. If we hold that the theoretical considerations which link carcinoma and sarcoma with diseases which are certainly parasitic, making us believe that that disease will ultimately prove to be due to a micro-organism, we can easily understand how this organism of cancer lighting upon mesoblastic tissue may produce a malignant sarcoma; while if it lights upon an analogous epithelial cell, it will produce a carcinoma; so that the difficulty which is represented in the paper of the President fades away before my vision, seeing that I hold, as far as it is possible to hold a thing that we do not yet know, that this disease will ultimately prove to be due to a micro-organism.

I should like to add one word with regard to the paper of Professor Trendelenburg. He may not remember me, but in 1883, I was at Leipsic, and I well remember his kindness and attention toward me as an English student at that time. I remember also seeing one of his cases of ectopy which he had operated upon and in which he gained a good result.

I should like to mention also that one of my old teachers was one of the first to transplant the ureters into the rectum or sigmoid flexure, and also had exceedingly good results. Although many of these cases had a suppurative pyelitis, followed by death, in others the patients were able to hold their urine in the cloaca produced for three or four hours, and in that way were able to get about their business and do the work of life in a fairly satisfactory manner.

Dr. Archibald MacLaren, of St. Paul.

I think we are all agreed that cancer of the rectum should not be considered as wholly inoperable except in a small minority of cases. I doubt whether extirpation of the glands is going to improve the ultimate results, although we are all anxious to know how much may be accomplished along this line.

As to the possibility of extirpating cancer of the rectum within a finger reach of the anus, I will say that in the last year I have been able by simply removing the coccyx to bring out as much of the sigmoid as one could wish, extirpate six inches of the rectum, in one case, and eight inches n the other, strip the mucous membrane out of the sphincter, pull the bowel to the skin edge, attach it, and have had two excellent functional results, with perfect control for a limited length of time. Whether there will be return or not, time only will tell.

Professor Trendelenburg. In reply to the remarks made by Dr. Keen, while I never saw a woman become pregnant after the opera-

tion I have mentioned, I am sure there would be no difficulty attending that condition. Also, the two valves are not closed together, and the woman is in the same position she would be after a symphyseotomy.

As to the second question, there is no impediment in walking by loosening the ilium at the sacroiliac synchondrosis. There is no complaint on the part of the patient from that source.

As to resection and drainage, I have tried this several times, but have not been satisfied with it because the wounds become infected with urine; we have suppuration, and afterward there are tight and firm scars, and it is difficult to deal with scars if you are obliged to operate another time. That is the reason I have abandoned that method of procedure.

SOME EXPERIENCES IN INTRACRANIAL SURGERY.

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SYLLABUS.

Tumor of brain: difficulty of early diagnosis; histological evidence of malignancy sometimes deceptive; dural flap in occipital region; tremor in frontal lobe tumor; relation of brain tumor to injury; bulging of occipital fossa in cerebellar tumor; long survival after operation for cerebellar tumor; diagnosis between extra- and intracerebellar tumor; brain tumor in the insane. *Subdural hematocele:* remediable by operation. *Abscess of brain:* shape and growth, drainage through the stalk, Roncali's case, brain abscess following influenza. *Meningitis:* meningitis serosa; hydrocephalus interna (two methods of operative treatment); tuberculous meningitis; general suppurative meningitis. *Conclusions.*

Surgical intervention is, at present, our only remedy for certain intracranial diseases, but only too generally the same apathy prevails in adopting this remedy as was prevalent some twenty-five years ago in operating for analogous diseases in the abdomen.

I propose to offer some remarks suggested by my own experience in operating for tumor of the brain, abscess of the brain, subdural hematocele, meningitis, and hydrocephalus interna.

Tumor of Brain.

Prominent among the obstacles to successful operation for intracranial disease and particularly for brain tumor is the difficulty of making a precise diagnosis at an early stage of the disease.

Not many years ago the nature of many abdominal diseases was not ascertained until the abdomen had been opened. In the early Listerian days the condition found on opening the abdomen often differed widely from that expected. This is much less frequently the case now.

The diagnosis of intracranial disease is, speaking generally, a far more complex problem than that of intra-abdominal disease, and, moreover, within the skull an exploratory operation cannot be conducted in the same rapid and complete manner and with so little serious risk as in the abdomen.

The maxim that diagnosis must precede operation is only true of those diseases the signs, symptoms, and course of which are fully comprehended. When the early clinical manifestations of a disease are ill-understood and when danger attends delay the surgeon is content to act upon a provisional diagnosis. Many lives are thus saved and diagnosis becomes perfected.

It is still true that we sometimes open the abdomen expecting to find some grave condition and find nothing: for example, some three years ago a man aged fifty years was sent to me who had been ill for six months with vomiting, pain in the abdomen, and marked emaciation. Nothing abnormal was found on opening the abdomen: but the patient was cured. He gained flesh rapidly and returned to work. He was seen in April this year and was well then. In such cases no adequate cause for symptoms is found and it is difficult to understand why improvement follows the operation. In the relatively not uncommon cases in which an expected intracranial tumor is not found at operation, one definite pathological condition, namely, increased intracranial pressure, is, I believe, always present. This is certainly relieved by the operation.

Nonne, among others, has called attention to cases with symptoms of cerebral tumor which (1) recover without operation and remain well for years, (2) recover after an operation at which no tumor is found, (3) die and no tumor is found at the postmortem examination.

The following case is an example from my practice of symp-

toms without discoverable tumor of brain: Mr. T., aged twenty years. For fifteen months before I saw him he had suffered from attacks of occipital headache, diplopia, and vomiting. In some attacks the vomiting was severe and prolonged over several days. When seen there was optic neuritis on both sides, but more advanced on the right than on the left side; nystagmus on looking to the right and diplopia on looking to the right. There was inco-ordination of the movements of the right hand. The gait was slightly unsteady and it had been noticed that in crossing a street he was apt to knock his right foot against the curb, and in walking down a passage to brush against the wall with his right shoulder. He had frequent attacks of agonizing headache commencing in the right eye, then becoming diffused and spreading down the back of the neck. These attacks were associated with urgent vomiting, irregular pulse, and slow, deep and irregular respiration. During the headache, tenderness of the right occipital fossa was observed. Operation: Nothing was found in the right cerebellar fossa. Great tension of dura relieved by lumbar puncture before incision. The patient now nearly two and a half years since the operation is well and can play two rounds of golf.

Exploration is greatly facilitated and damage to brain tissue saved by doing lumbar puncture before opening the dura.

It seems that the symptoms we take as indicative of tumor are the clinical expression of a slowly increasing morbid process, in the brain of which tumor is not the only possible cause.

Another point of practical interest is that a highly cellular tumor of the brain is not necessarily very malignant. This is true not of brain tumors only but of tumors of other parts of the body; thus a large cellular carcinoma mammæ may prove less malignant than a small atrophic scirrhus with few cellular elements.

In 1903 I drained a large gliomatous cyst in the left frontal lobe of a man under the care of Sir William Gowers. The symptoms were relieved but recurred two years later. I then removed a large mass of tumor from the same region. The patient left hospital well and proposed to resume his work. The tumor

was a highly cellular glioma. Tumors behind the Rolandic area may have special sensory disturbances which distinguish them from frontal lobe lesions. For example, a gentleman who, when seen, had complete left hemianopsia had been much troubled five years before with catherine wheel spectra on that side. At operation it was found that he had a psammoma of the right occipital lobe.

An incident in this case illustrates an important practical point. In the occipital region the scalp-flap is thrown downward, but the base of the dural flap should be at the anterior border of the wound, for then it will carry with it the meningeal arterial supply and be in no danger of sloughing.

Attention has recently been drawn by Grainger Stewart to important localizing signs in frontal lobe tumors, namely, fine vibratory tremors of the homolateral limbs and absence of the epigastric and abdominal reflexes on the contralateral side.

The localizing value of hemianopsia is particularly great when it is the first among the symptoms of tumor to attract attention. The same applies to other localizing signs such as mental change in frontal tumor or deafness in fibroma of the auditory nerve. When these or other localizing signs appear long after the syndrome symptoms they afford much less sure indication of the site of the tumor.

In some cases brain tumor has directly followed, and apparently resulted from, a serious injury to the head; and in many others there is a history or direct evidence of a former injury to the head.

In 1895 I operated for brain tumor on a coachman aged thirty-one years. He had suffered from severe headache for a year and his sight had been failing for nine months. It was ascertained that left hemianopsia had been observed at another hospital. On admission he had severe headache and vomiting. He was almost totally blind and hearing was much impaired on both sides. Both disks showed atrophy from neuritis. Mental state tending to torpor. He denied having met with any injury to the head. At the operation a healed fracture was found in the

right occipital region. It was afterward elicited that twenty years previously he had been rendered unconscious for several hours by a kick from a horse. Beneath the healed fracture was a cystic glioma of the occipital lobe.

Malignant growths have, in some instances, a purely local origin; in the same way that a purely tuberculous infection may arise from direct inoculation and remain a local though a spreading disease. Local irritation or injury often precede the manifest presence of tuberculous or malignant disease. The main argument against the view that local irritation and injury are associated with the outbreak of these diseases is that a larger proportion of those exposed to local irritation or injury would in that case become infected. But the efficient cause of tubercle or malignant disease lies beyond the mechanical irritation, which is but the partial cause of the disease, and the question resolves itself into this, Why are some persons infected in such circumstances whilst others escape?

Last year an admirable symposium of present knowledge in regard to cerebellar tumors was published by distinguished members of our profession in Philadelphia.

There is one point to which I should like to draw attention, namely, the bulging of the occipital fossa in cerebellar tumor in childhood.

1. In 1889 I removed a tumor from the cerebellum of a child aged three and one-half years. The main localizing sign was a bulging occipital fossa.

2. Last year a boy aged six and a half years was admitted to my ward in the Great Ormond Street Children's Hospital with signs of cerebellar tumor. The right cerebellar region was slightly the more prominent. This sign, anatomical in this case, led to exploration on the wrong side. The symptoms were equivocal. Shortly they were: paroxysmal headache, vomiting and cerebellar gait. Unsteadiness in standing but without marked tendency to fall to one side more than to the other. Deviation to the right in walking and in running. Inco-ordination of limbs to an equal extent on the two sides. Optic neuritis on both sides

most marked on the left. The attitude of the head was that described by Batten as corresponding to left cerebellar tumor, but it is well known that the attitude of the head is not conclusive as to the site of the disease. This case presents an interesting study in its demonstration of how an erroneous first impression works out to a false conclusion, and in this particular instance to ultimate disaster, as though the cyst was drained at a second operation; the child did not survive.

In the ward were two other cases:

3. Male, aged four years and ten months. Left occipital fossa bulged considerably. Inco-ordination of left upper limb. Large tuberculous tumor removed. Child now well.

4. Female, aged seven years and ten months. No bulging of occipital legion. No regional diagnosis possible. Right cerebellar region first explored, then left. Large tuberculous tumor removed. Patient made good progress for three months. Death then occurred suddenly from hemorrhage, possibly scorbutic in origin, tearing up the whole left cerebral hemisphere.

To prove that operation for cerebellar tumor in the adult may be completely successful, I may mention that in 1894 I removed an encapsuled fibrosarcoma from the right cerebellar fossa of a woman aged forty-nine years and that she is alive and well now.

My junior colleagues, Grainger Stewart and Gordon Holmes, in an able paper, have pointed out that a diagnosis may be made between intra- and extracerebellar tumors. In extracerebellar tumors the syndrome symptoms are not so severe as in tumors of the lateral hemisphere, the cranial nerves are more likely to be involved, and the subjective rotation of self is to the side of the lesion.

TUMORS IN THE INSANE.

Another most interesting subject in relation to tumors of the brain is their presence undiagnosed in the insane. It is of course to be expected that tumors may produce mental symptoms and also that tumors of the brain may arise within the crania of

patients insane from others causes. Mr. Cecil Beadles has collected a considerable number of brain tumors from autopsies on insane persons. These cases will shortly be published. The following is an example of this coincidence:

A woman aged sixty-nine years had been nineteen years in an asylum. She was a melancholic. After being three years in the asylum she began to suffer from left facial palsy and severe hemicrania. At the autopsy a large endothelioma of the meninges was found in the left frontal region, causing a deep depression in the brain. This form of tumor grows very slowly.

A similar case of which I will show a lantern slide is related and figured by Cruveilhier. The patient was a female, aged forty-five years, and was seen by Cruveilhier on September 3, 1829. She was unable to walk, was mentally feeble, had severe right frontal headache, slow speech, involuntary micturition, and weakness of the left leg.

She died on October 3, 1829. Cruveilhier had the satisfaction of demonstrating that his diagnosis of the site of brain tumor was correct.

ABSCESS OF BRAIN.

It is now generally recognized that an abscess in the brain should be treated like an abscess elsewhere. In most cases of slowly spreading infection from chronic disease adhesions occur at the site of infection binding together dura, arachnoid, pia, and cortex. The lymphatic sheaths of the numerous small bloodvessels which traverse the cortex at right angles to its surface are in direct communication with the subarachnoid space and through these, as through a number of capillary tubes, infective matter easily traverses the cortex and reaches the white substance within. The cortex is very vascular, and its connective-tissue element, reinforced by numerous prolongations from the pia mater, is abundantly supplied with connective-tissue corpuscles. Hence, it is able to offer a strenuous resistance to the bacterial attack, and does not ordinarily undergo any extensive destruction. Where it is traversed by the infective material a barrier of fibrous tissue

is thrown out, limiting the destructive process to the formation of a narrow track. The white substance is much less resistant and it would seem that the greater the distance from the cortex the more easily does bacterial action cause dissolution of brain substance. Thus the abscess comes to assume a mushroom-like shape, with the narrow portion or stalk attached to the dura at the original site of infection from the bone. Preysing's figures admirably illustrate this important fact, and his paper gives us an example of valuable suggestions for treatment obtained by carefully conducted anatomical dissection, for the stalk is the track through which the infection entered. Its lumen presents a ready made channel, with fibrous walls through which drainage can be effected and the infective material made to leave the brain. This natural tube is not liable to be obstructed by the flowing together of the liquid substance of the brain by which the efficiency of all forms of artificial drainage tube is so much impaired. If then the abscess can be tapped through the stalk itself without passing the knife through healthy cortex and meninges, there would be efficient drainage without risk of suppurative meningitis or of hernia cerebri. I have found this plan of drainage through the stalk the most successful.

It is hardly necessary to observe that an encapsuled abscess should not be opened and drained but enucleated.

A case published by Roncali illustrates the grave danger of a prolonged course of treatment not founded on a just appreciation of surgical principles. When the case came into Roncali's hands an adequate operation was carried out, but it was then too late to save life.

I have known three cases of brain abscess following influenza without local bone disease. In these the abscess was chronic with thick walls and contained greenish pus. Between the influenzal attack and the onset of the urgent symptoms which immediately preceded death there was a latent period of one to three months. During this time the patient, though apparently convalescent, suffered from headache.

SUBDURAL HÆMATOCELE.

Bright, Prescott Hewitt, and others have observed and recorded arachnoid cysts derived from hemorrhage; such cysts often give rise to symptoms of brain tumor or render the patient insane. Satisfactory results are obtained by removing such cysts. In a case of mine already published a cyst seven by four and one-half by one and one-half inches was successfully removed. I have since met with three other cases. In one of Prescott Hewitt's cases the patient, a boy, received a blow on the head from a cricket ball. He lived for fifteen years, during which time he suffered from intermittent insanity.

Bearing in mind that in almost all serious head injuries blood is extravasated into the arachnoid cavity, it may well be that in certain cases of intermittent headache, intermittent paralysis, or intermittent insanity subsequent to head injury the pathological lesion present is arachnoid hematocele—a condition certainly remediable by operation.

MENINGITIS.

A remark may be made about meningitis serosa, a condition which often arises when pus collects outside the dura, as, for example, in some cases of acute mastoid suppuration. The symptoms are rise of temperature, slowing of pulse, sluggish pupils, sickness, and drowsiness. All these symptoms may be promptly relieved by lumbar puncture. The withdrawal of fluid may prevent the meningitis going on to suppuration, just as the removal of fluid from the pleura by the aspirator relieves the lung from pressure and may prevent the pleurisy going on to empyema.

Hydrocephalus interna is met with in infants as a congenital condition or as the result of posterior basal meningitis, the congenital form has resulted from intrauterine meningitis.

We have two methods of dealing with hydrocephalus.

1. *Intradural Drainage.* This can be carried out through the lateral angle of the anterior fontanelle, or the descending

cornu of the lateral ventricle on the right side may be opened by the ingenious method of Keen. A fine tube, bent at a right angle made of gold and iridium, or of pure platinum should be used.

2. *Ligature of Both Carotids.* The secretion of fluid may be lessened by ligature of one or both common carotid arteries. This can be safely done in hydrocephalic infants, in whom the blood supply to the brain stem is of much more relative importance than that to the cerebral substance and the choroid plexus. I have had successful cases by both these methods.

Tuberculous Meningitis. I have published a case in which the removal of tuberculous disease of the temporal bone cured commencing infection of the meninges, as evidenced by headache, vomiting, and squint. The removal of local cranial disease in such circumstances is an obvious duty. Have we anything to hope from an intracranial operation when tuberculous meningitis is not due to local cranial disease? The results of opening the abdomen in tuberculous peritonitis have led to the hope that something would be accomplished by opening the skull in cases of tuberculous meningitis, but the few efforts that have been made in that direction have afforded but little encouragement. Must we accept the results hitherto obtained as final, and conclude that no benefit is to be derived from intervention? Before accepting defeat we should consider whether the measures hitherto adopted are those most likely to prove successful. In operating for tuberculous peritonitis we neither remove the disease nor the source of infection, and it is by no means clear in what way the modification in the evolution of the disease is brought about, but it certainly seems that exposure of the disease and drainage of the inflammatory exudation must be the main factors. The operation is simple and easy of execution.

A problem of much greater complexity confronts the surgeon who seeks to deal with tuberculous meningitis in the same way. Some of the operations hitherto performed have been limited to opening the subdural space; consequently, direct access to the disease and direct drainage have not been obtained; the subarachnoid space, where the disease lies, being left untouched.

This procedure is merely opening a neighboring cavity; opening the pleura could have little influence on disease in the pericardium. The disease is found in the ventricular cavities as well as in the subarachnoid space and some degree of internal hydrocephalus is often present consequent on the blocking of the foramina in the roof of the fourth ventricle or of the Sylvian aqueduct. Drainage therefore is required not only of the subarachnoid space but of the ventricular cavities. Two operations, not a single one, seem to be necessary, and herein lies the initial difficulty of successful surgical treatment.

Until more complete operations have been performed in an earlier stage of the disease we cannot say whether tuberculous meningitis is likely to be modified in the same favorable way by operation as is tuberculous peritonitis.

General Suppurative Meningitis. Kümmel and Hinsberg have both published successful cases of operation for this desperate disease. Hinsberg tells us that up to the present at least ten cases of recovery from meningitis after drainage of the subarachnoid space are known and five in which marked improvement took place. "It can no longer be doubted that in some cases of suppurative meningitis recovery may be brought about by active intervention. We are as yet quite unable to say how large a fraction that may prove to be, but we are no longer justified in regarding such cases as hopelessly lost, and in remaining with folded hands, but rather must we attempt to save them by doing the utmost within our power."

I am convinced that the treatment of intracranial disease has been too long encrusted with conventionality.

Cases of brain disease requiring surgical relief are numerous and widely distributed, but those who operate on them, especially on brain tumors, are few and far between. Not so long ago the same was true of acute abdominal diseases, but now the surgery of acute abdominal disease is successfully practised by the great body of surgeons. Until this stage in the history of brain tumors has been reached many remediable cases must go unrelieved.

DISCUSSION.

Dr. Dudley P. Allen, of Cleveland.

Did I understand you to say, Mr. Ballance, that no case of aneurysm in the interior of the skull has been diagnosticated before death?

Mr. Ballance. I expressed the opinion that no surgeon has heard the murmur of true aneurysm within the skull.

Dr. Allen (resuming). Some fifteen years ago a country practitioner, forty or fifty miles West of Cleveland, telephoned me that he had a case of aneurysm in the interior of the skull. I wondered how he diagnosticated it. I went at once to see the patient and on examination with a stethoscope found that a bruit could be heard very distinctly over the left side of the skull. I ligated the internal carotid on that side. The patient, however, gradually grew worse and died. At the postmortem we found on the left side an aneurysm of the circle of Willis, just where it had been diagnosticated.

Dr. N. B. Carson, of St. Louis.

I can refer to another case of aneurysm of one of the arteries of the brain diagnosed by consultation before death. The case was reported by Dr. Willis P. King at a meeting of the Missouri State Medical Association in the early nineties, in which case a diagnosis of cerebral aneurysm was made. The bruit was heard by placing a tube in the ear of the patient and in the ear of the physician. The diagnosis was confirmed by the postmortem examination, which was held some time later. A report of this case will be found in the Transactions of the Missouri State Medical Association on file in some of the different medical libraries.

Dr. John F. Binnie, of Kansas City.

Another case of aneurysm was reported in the Missouri State Medical Association, which followed Dr. Keen's case very closely, by Dr. John H. Thompson. In this case a very distinct bruit could be heard by the same method as that mentioned of placing a tube in the patient's ear.

Dr. W. W. Keen, of Philadelphia.

Unfortunately, I was called away during the reading of the earlier part of the paper, and I therefore cannot say anything with reference to that.

As intracranial aneurysm has been spoken of, I will say that I have operated on two cases, not of pure aneurysm, but of arteriovenous aneurysm. One of them I operated on in Chicago a number of years ago, and the patient, I am very glad to say, recovered entirely. Prior to operation, a bruit was perceptible not only in the head but also in the neck.

The second case was operated on at the Jefferson Hospital two years ago. In that case unfortunately I was obliged to tie both carotid arteries, a cure not having been effected by the ligature of one common carotid, and the patient died as a result of the second ligation. It was done earlier than I wished to do it; but the woman's symptoms became so severe that it was impossible to wait. Unfortunately, again, the family refused absolutely to any postmortem examination, so that I am unable to give the exact pathological findings.

I was particularly interested in what Mr. Ballance said in reference to brain abscess. I have had two cases recently that illustrate very well indeed the point that he made in reference to the stalk of the abscess. Both of them were traumatic cases. One was a very unusual case in origin, and most satisfactory in its conclusion. It was a young man who, in North Carolina, was standing alongside of a very rapidly revolving belt connected with some machinery. The two ends of the belt where they come together were held in place by metallic hooks, each end being curved, making an interrupted ellipse. Unfortunately, one of them was poorly tempered and the end of it straightened out, and was flung from the rapidly revolving belt, striking the patient a llttle above the right ear. The accident happened last July. The patient recovered from the wound; in the small town where he was there was no *x*-ray apparatus available to determine whether the bent hook was present, or if present, where it was, and as the surgeon probed for it, as far as was justifiable, and did not succeed in finding it, he closed the wound and the patient recovered. He had two epileptic convulsions in the month of March, if I remember rightly, and in addition to that he became hemiplegic on the left side. As soon as he was brought to Jefferson Hospital, an *x*-ray picture was taken, which showed the presence of this belt hook with one end almost straightened out, and in a position just above the ear, near the surface, precisely where it had entered. I opened the skull, making a very small increase in the size of the opening that had already been made by the surgeon at the time of the accident, and at the suggestion of Dr. Alfred Gordon I endeavored to remove the hook by one of the large magnets used in the eye department for the removal of fragments of iron in the eye. Unfortunately, it was utterly unsuccessful. Accordingly, I introduced a pair of forceps, and very quickly found and removed the hook. This

use of the magnet would have been not only a very beautiful use of the magnet, but evidently would have done much less harm to the man's brain than would be done by any instrument with which the surgeon would, so to speak, grope around in the brain. It was evident then why the magnet had not been able to draw out the hook. The amount of force that was required to remove the bent hook was considerable. I presumed it to have been due to the encapsulation which Mr. Ballance has referred to, in which sometimes an abscess will roll about like a billiard ball, an observation already made, you remember, by Dr. Macewen, a number of years ago.

The patient recovered not only from the operation, but from the hemiplegia.

Dr. Ellsworth Eliot, Jr., of New York.

I would like to inquire of Mr. Ballance, when he closes the discussion, whether in cases of chronic hydrocephalus treated by the ligation of both common carotids the improvement he noticed was permanent or temporary, and if temporary, how long the improvement continued?

I did not understand whether, in these cases, both common carotids were ligated simultaneously, or whether an interval was allowed to elapse between the two operations.

Dr. John B. Roberts, of Philadelphia.

Mr. Ballance spoke of the similarity between abdominal surgery and brain surgery and of the reluctance of some to operate for disease of the brain. It occurs to me to mention a similar similarity seen in the past winter. I operated for brain abscess, and found a piece of gauze within the skull which had been left there by a previous surgeon, thus showing another similarity between abdominal surgery and brain surgery.

Dr. Joseph D. Bryant, of New York.

Some time ago I had occasion to see a patient with Dr. Rushmore, whom I notice is here, in which there were distinct symptoms, as evidenced by auscultation, of a murmur, associated with some important vessels at the base of the brain. It would be interesting if Dr. Rushmore would inform us regarding the outcome of that case.

Dr. John D. Rushmore, of Brooklyn.

In the case Dr. Bryant has referred to there was trauma, followed by pulsating exophthalmos, and a bruit. I tied the common carotid, with temporary relief, but subsequently the bruit returned subjectively

and objectively. I then tied the vertebral high up where it entered the skull, and with a brief period of relief, and then it came back objectively, but not subjectively. To the ear of the listener, it was as loud as ever, but the patient was entirely free from the annoying sound. I do not know anything about the subsequent history of this case.

September, 1906, four years and a half after last operation, patient is at work, the exophthalmos diminished and the bruit noticed by him when he fixes his mind on it.

Dr. L. L. McArthur, of Chicago.

Lest some future surgeon discover a piece of gauze in the skull left by some preceding operator I would like to report a case of aneurysm in the calvarium. In making a trephine opening a portion of the trephine entered the aneurysmal cavity. I quickly enlarged the opening, but in doing so it still showed such a desperate hemorrhage that compression of the carotid was made. While the compression was made I packed iodoform gauze into the bleeding cavity, proceeded then to ligate the left carotid, closing my skin-flap over the embedded gauze. The man recovered. He lived for a year or more. When a postmortem examination was made, the aneurysm found, *and the gauze.* The surgeon was criticized because the gauze was left in the wound.

Mr. Ballance (closing the discussion). I wish to thank the members of the Association very much for the kind way in which they have received my paper.

With regard to aneurysmal murmur, of course I exclude arteriovenous aneurysm, the murmur of which many of us have heard. What I meant to say was this, that I was not acquainted with anyone who had heard with the stethoscope on the head a murmur from a true aneurysm of one of the vessels in the circle of Willis, for instance. I had forgotten I was in America.

With regard to the treatment of chronic hydrocephalus, I do not think I was the original person who tied the two common carotid arteries. I am not sure whether I was or not. It has been done by Mr. Stiles, of Edinburgh. In my cases I allowed ten days to elapse between the ligation of the two vessels. I have not had any trouble in ligating both common carotid arteries in cases of hydrocephalus interna in children, and that is an excellent method for certain cases because it arrests the secretion of fluid from the choroid plexus. The other method of subdural drainage is good in some cases and must be resorted to after the ligation of both carotids fails.

THE TREATMENT OF CONGENITAL DISLOCATION OF THE HIP BY INCISION.

By E. H. BRADFORD, M D.,
BOSTON.

At the present stage of the development of the treatment of this deformity there can be no question that the operation of choice is that of reduction by operative manipulation. This is not only the simplest and safest method, but in a considerable number of cases most satisfactory results can be obtained without the employment of any other means; but in a not inconsiderable percentage of cases complete ultimate success is not obtained, and the cases are either to be classed as failures, or at best as only somewhat improved.

It may be premised that by a success in the reduction of congenital dislocation of the hip is meant the placing of the head in its normal position in the acetabulum, enabling the joint to exercise the function for which it was intended. A functional success or transposition, as it has been termed, where the head remains without the socket, should be considered a failure even though the patient is somewhat benefited by the surgeon's endeavor.

The causes of these failures have been carefully considered, and are attributable either to imperfect reduction or to a lack of the proper anatomical relations needed for securing permanent reduction. In the latter category absence of the acetabulum, great distortion of the head or acetabulum may be regarded as relatively rare, and the former, viz., imperfect reduction, meaning by that the failure to stretch the contracted and shortened soft parts in such a way that the head can be placed opposite or within the

socket, is at present not to be considered in the hands of surgeons experienced in this procedure, is not a usual cause of ultimate failure.

The question, therefore, is of importance where the anatomical conditions are adequate for reduction, and where the usual amount of skill is employed in the attempt at manipulative reduction, the number of final results are not those of complete success. It will be conceded without question that these failures occur, and the proper treatment in such cases is a subject for the careful consideration of the surgical world, if the treatment of this deformity is to be placed upon a basis of greater exactitude than at present is the case even in the practice of surgeons of experience.

The causes usually assigned for these failures are as follows: first, a shallow condition of the acetabulum; and second, a lax or faulty condition of the capsule. As to the shallowness of the acetabulum, after skiagraphic records are taken of cases of congenital dislocation, a so-called shallow acetabulum will be found to exist in a considerable number of cases, especially in young children. If these data were considered conclusive, it would be found that the number of cases which could successfully be treated by manipulative reduction would be exceedingly small. These data, however, are not in accord with clinical experience, where it is not uncommon to successfully reduce a hip, as shown by the evidence of the characteristic slipping of the head over the acetabular border, while on *x*-ray examination it will appear that no such acetabular border exists. Furthermore, on *x*-ray examinations, in many instances successful reduction has been accomplished even where on skiagraphic examination a shallow acetabulum is present, and where after several years of observation the normal acetabular lip is seen in later skiagraphic pictures to have been developed.

The explanation of this apparent anomaly will be found in the fact that although the bony rim of the acetabulum, in all cases in children to a certain extent, and to a much greater extent in congenitally dislocated hips, does not project enough to retain the femoral head without the elongation of the cartilaginous border,

viz., the cotyloid ligament and the capsular ring (zona orbicularis). Where the head is held firmly by this cartilaginous cup, in infants, the hip is held firmly in place. Where in fœtal congenitally dislocated hips the head is not so held, the femur can be pressed upwards and backwards, and the condition known as congenitally dislocated hip results. This dislocation is loose or firm according to the strength of the contractions and adhesions of the distorted capsule, and the reduction is complete or a failure according to

FIG. 1.—Section of normal hip, showing acetabulum, zona orbicularis, and glenoid ligament.

the success of placing the head within the cartilaginous rim which completes the acetabulum.

This statement can be demonstrated by an examination of a series of normal hips in children, from the fœtal stage up to that of adolescence, showing the gradual development of what may be called an acetabular or bony shallowness up to the shape of the acetabulum seen in adults. This can also be made even more convincing by the examination of the pathological condition of the

acetabulum in such specimens of dislocations of the hip as have been subject to careful examination. These range from specimens in fœtal life to that of adults.

Other changes of importance in this connection are the changes in the condition of the capsule. As is well known, and was shown in the classical paper of Carnochan, in the congenital dislocation of the hip-joint the capsule is not torn, but is stretched upwards, and the acetabulum is covered by the lower portion of the capsule stretched like a drum head across the cavity.

The changes that take place after locomotion in the capsular structures are of importance. The capsule becomes naturally thickened and stronger as it becomes a weight-bearing band passng from the head and neck of the dislocated femur to the pelvis. Firm abnormal connections are developed in periarticular ligaments to both the pelvis and the femur. The capsular attachment around the head of the femur will be found less around the neck and more around the end of the head of the femur than is true normally. There are firmer attachments also to the lesser trochanter, and often strong bands running between the lesser trochanter and the upper borders of the acetabulum.

In addition to these are the changes in the interior of the capsule. Normally, the capsule consists of a bag, which passes from around the rim of the acetabulum, containing in its walls the cotyloid ligament, and is attached to the neck of the femur just below the head. As the head is well placed against the bottom of the acetabulum, no fold of the capsule lies between it and the acetabulum. In a congenital dislocation of the hip, in addition to the changes in the walls of the capsule, abnormal cartilaginous developments may take place. Where the capsule is drawn tightly upward and backward it is distorted, and the fibrocartilaginous structures, which normally lie in the capsule around the neck, the vestige of the cotyloid ligament and zona orbicularis, instead of being placed around the neck will be stretched between the head and acetabulum. Under certain conditions (and at present we are unable to know what those conditions are) this fibrocartilaginous collar, with its tendency to develop as a

constricting band, becomes constricted in front of the dislocated head and constitutes an obstacle to the successful reduction, lying close to the shallow bony rim of the imperfect acetabulum. In some instances this constriction makes the lumen or cotyloid ring in the capsular ring relatively slight. Sometimes the lumen is much smaller than the head. In other instances, while the lumen may be sufficiently large, abnormal developments in the growth of the vestiges of the cotyloid ligament are to be found in the lower border and inner portion of the acetabulum, constituting

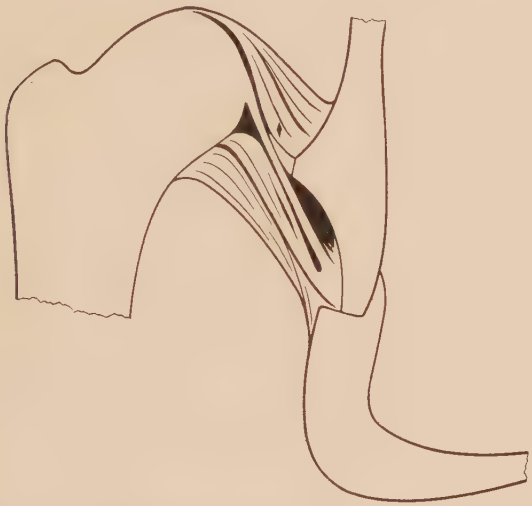

FIG. 2.—Section of a congenitally dislocated hip, showing the stretched capsule thickened and covering the bony cotyloid cavity.

firm abnormal fibrocartilaginous folds at the lower portion of the acetabulum.

In what percentage of cases the lumen of the capsule is as wide as that of the head, and in what it is smaller, it is impossible to say. Judging from the examination which is possible where an incision is made into the dislocated hips, it would appear that some constriction of the capsular lumen exists in a third of the cases in children under ten years of age. Where this constriction is not

great, it may be reasonably supposed that it is entirely obliterated by the stretching, that manipulations are used in manipulative reduction, and that it is not difficult to pass the head of the femur through the capsular lumen well into the acetabulum. Where, however, abnormal developments of the vestiges of the cotyloid ligament exist, and there is present a tight and firm band of fibrocartilage between the head of the femur and the bottom of the acetabulum, it is manifest that no amount of stretching will be effectual, and the reduction even of the head simply presses this mass of fibrocartilage into the acetabulum, which forms a cushion between the bone and the femoral head. In other instances, even where the capsular lumen is sufficiently large to permit of the passing of the head into the acetabulum, if abnormal cartilaginous folds or capsular wrinkles are present at the lower border of the acetabulum, the head is not introduced into the socket to a sufficient depth.

The condition of the reduction may be likened to that of a large ball placed within a boy's mouth. Where the mouth is sufficiently large to enable the ball to be passed within the rim of the teeth of the upper and lower jaws, the ball is imperfectly held if the lower lip intervenes between the teeth and the ball. It has been claimed that the pressure of the head of the femur into the acetabulum will cause absorption of the capsular fold or capsular irregularities lying between the head and the bottom of the acetabulum.

While it is possible that this may be true in a certain number of instances, judging from analogy it cannot be universally true. Fibrocartilage is apparently not absorbed under pressure, the intervertebral disks and the semilunar cartilage remain unabsorbed after pressure and usage for years. It may be considered, therefore, that in a large percentage of cases of failure on reduction by the manipulative method, the fault lies in the fact that it is surgically impossible by means of manipulation to place the head of the femur well in the acetabulum, and to surround the reduced head with a sufficiently firm retaining capsule as will prevent redislocation after the limb is actively used, and it may be claimed

that the cure of congenital hip dislocation consists not only in placing the head of the femur well within the acetabulum, but in putting the head of the femur in such a relation to the cartilaginous and ligamentous lips of the acetabulum that the femoral head will remain in place.

It is manifest that if this abnormal condition of the distorted cotyloid ligament exists relief cannot be obtained by repeated attempts at forcible manipulation; but success can only be obtained, if obtained at all, through the aid of incision.

The earlier attempts at reduction by incision were based upon the hypothesis that there was either an absence of the acetabulum or an imperfect condition of that portion of the joint, that it was

FIG. 3.—Diagram showing elongated capsule freed from femoral head in a congenitally dislocated hip without capsular constriction.

shallow and needed to be deepened, that it was filled up by functional extraneous matter. Of the early methods of relief of this deformity by excision of the head, nothing need be said except condemnation. The early attempts made to place above the head a fold of periosteum may be discarded as inadequate. Attempts to deepen an acetabulum regarded as imperfect by gouging or curetting the acetabulum, making it sufficiently deep to form a basis of support for the replaced head, have been frequently employed and have been used by the writer in upwards of thirty early cases. Much has been written in regard

to this procedure, but if the facts already presented as to the relative bony shallowness in children are taken into consideration, it will be seen that, although it is possible to obtain successful results by this method, anatomical or pathological facts suggest another method as perhaps preferable. If it is possible to retain any portion of the capsular folds and utilize them as a means of holding the reduced head in place, it is manifestly better to do this than to destroy such tissues. An attempt should be made not so much to make the hole of the acetabulum deeper, as to render it more effective by reconstructing the acetabular rim.

In performing reduction by incision certain difficulties are met. First, the difficulty of adequately stretching all the contracted soft parts. This is the difficulty which was practically insuperable in the earlier attempts at reduction by operative means, and it is this which led to the unnecessarily severe methods of excision. At present, owing to the experience gained by the method of reduction by manipulative means, it is possible to overcome all muscular contraction. This should be done thoroughly, previous to any attempt at reduction by incision. This can be done either by the usual means, manual manipulative reduction, or, as is preferred by the writer, by the use of stretching apparatus. All muscular contraction must be entirely overcome, and all capsular shortening also, as far as possible, including also the shortened condition of the fascia lata and of the iliotibial band.

This preliminary stretching may be done at the time of the operation by incision, or at a preliminary operation, and may be aided or not by tenotomy, as may be necessary in the individual case; and by tenotomy is meant tenotomy of the iliotibial band of the fascia lata passing over its attachment at the anterior superior spine, and in the severest cases by a tenotomy of the tendon of the adductor magnus. The latter tenotomy, however, will be rarely needed and should be regarded in most instances an unnecessary procedure, and in mild cases an injurious one, as perhaps leading to a subsequent weakening of the limb.

After the stretching, the head should be reduced by manipulation as far as practical and passed under the upper acetabular

rim, or as near to this as is possible. The patient is to be placed upon the side, and an incision made passing from the anterior superior spine obliquely, backward and downward. The incision should be made in such a way as to avoid cutting across the gluteus medius muscle. If the dislocated head is placed as near the surface as possible, the incision is more rapidly made, the object being to clear the dislocated femoral head. As soon as the head is cleared by means of incision and blunt dissection, the limbs should be twisted in such a way as to bring the head as far forward as possible, and a cross incision should be made of the capsule where it is joined to the head. The cut portion of the

FIG. 4.—Diagram showing elongated capsule freed from femoral head in a congenitally dislocated hip with constriction of the capsule at the mouth of the cotyloid cavity.

capsule on the side nearest the acetabulum should be seized by pressure forceps and secured by sutures and the head entirely freed from its capsular attachment.

The attachment of the capsule to the lesser trochanter and to the femoral neck should also be severed, care being taken that the cut capsular border should not be lost, but retained by strong silk sutures. It is then necessary to pull the head of the femur well away from the wound, and that the freed cut folds of the capsule be carefully retained. The capsular lumen should be then thoroughly inspected, not only the portion which has been close to the femoral head, but that portion which is in close contact with the

bony rim of the acetabulum. It will not infrequently be found that, although the capsular lumen may seem sufficiently large, exploration by the finger will show cartilaginous or capsular irregularities near the bottom of the acetabulum. Where the ligamentum teres is not absorbed, it will be necessary to divide this in order that the surgeon may have sufficient room for proper examination of the capsular lumen. The rest of the procedure resolves itself into the simplest methods of passing the head through the capsular lumen well into the bottom of the acetabulum.

It must be repeated that for this it is essential that all muscular contraction shall have been overcome. Even with this, however, in some instances it will be found difficult to slip the head well into the acetabulum without crowding portions of the capsule before it. The surgeon should, after careful examination, determine whether the passage of the head through the lumen will be easy or difficult. Where it is difficult, owing to the constriction of the capsular lumen, dilatation of the capsule is necessary. This is best done by securing the capsular walls by strong silk sutures, making the capsule tense, and passing the finger well into the capsular lumen, placing the blunt point of a herniotomy knife well down into the bottom of the acetabulum, and cutting directly downward.

It will be thought that a certain amount of risk is run in the possibility of the division of some branch of the profunda artery. This risk cannot be regarded greater than is incurred in the ordinary operation of herniotomy. It is, however, a risk that is to be considered. In the experience of the writer, this danger is not great. In only one instance of the operation by incision attempted at the Boston Children's Hospital was any bleeding encountered in incising the capsule. This was checked by enlarging the wound, separating the attachment of the quadratus femoris, and securing the bleeding point by pressure forceps.

After the capsule has been divided in this way, attempts should be made to place the head well in the acetabulum, without the folding in of the capsule as the head is introduced. In cases of difficulty the writer has made use of especially constructed retractors, which

are passed, one above and one below, well into the bottom of the acetabulum, pressing like a shoe-horn the tissues away from the introduced head. After the head has been placed well in the acetabulum, it is necessary that it should be secured in this position in such a way that it will not slip, and various means have been tried for this purpose. The suggestion of Codivilla that the head of the femur be tunneled, and that the ligamentum teres be passed through and secured in the tunnel, is not only an ingenious but a brilliant one, but as the ligamentum teres is absent in many

FIG. 5.—Diagram showing imperfect reduction of a congenitally dislocated head owing to folded capsule in front of the partially reduced head.

instances, it cannot always be relied upon for the purpose of holding the head from slipping. For this purpose sutures can be utilized.

The neck of the femur can easily be pierced, and a silk or chromicized catgut suture passed through the neck of the femur. This can be tied to the silk sutures, which have been passed firmly through the capsule. The head of the femur can in this way be well secured close to the acetabulum. The writer has tried various methods of passing of sutures in the capsule, but this is a matter which can be left to the manipulative skill of different

surgeons who will, in employing the method, use different means to accomplish the desired result, which is not only to secure the head of the femur well in the socket with the certainty that no capsular folds or cartilaginous obstacle lie between it and the bottom of the acetabulum, but also to place the parts in such a position that cicatrization will develop a retaining ring around the neck of the femur. The wound is closed and the limb placed in a fixation bandage or a retention apparatus.

The position in which the limb is placed is one which requires considerable thought. While the frog position is serviceable after manipulative reduction, its value is less after reduction by incision, and it will be found that the most convenient position will be that of the limb abducted to about 45 degrees. A plaster-of-Paris bandage is applied and a window cut over the wound. In later cases the writer has been in the habit of trying a retaining splint, avoiding the need of plaster bandages, but as the number of cases in which this has been tried is at present but few, a definite opinion as to the value of this method cannot yet be formed. In the ordinary case the wound heals by first intention, and at the end of three weeks the surgeon is able to determine whether a satisfactory result has been obtained or not.

The dangers which are met are, first, the danger of sepsis, and second, the danger of inadequate retention of the head in the socket and consequent slipping and failure. The former danger will always be present and demands unusual care. In a number of cases of incision of the hips it will be found that some elevation of temperature follows the operation, even if careful aseptic precautions have been employed. This is explained by the fact that it is extremely difficult to prevent the introduction of some skin cocci into the wound, the acetabular cavity not being as well furnished with absorptive walls as the peritoneum and is therefore intolerant of any fermentation of retained fluids. It is also often difficult in very young children to prevent in all instances contact of urine with the dressing, and for this reason not only is the greatest care needed, but the employment of the method of incision itself may be regarded as a grave one in very young children.

Theoretically, it is possible in all cases to prevent sepsis, but practically, the risk of sepsis must be always seriously considered. It is also theoretically possible to secure by proper sutures the head of the femur so that it may not slip from the acetabulum until such time as the tissues have resumed their normal retaining power and dislocation does not occur. Practically, however, difficulty is often encountered in securing the sutures with such accuracy as to serve as a means of retention during the period of healing. This is a difficulty which greater experience may be

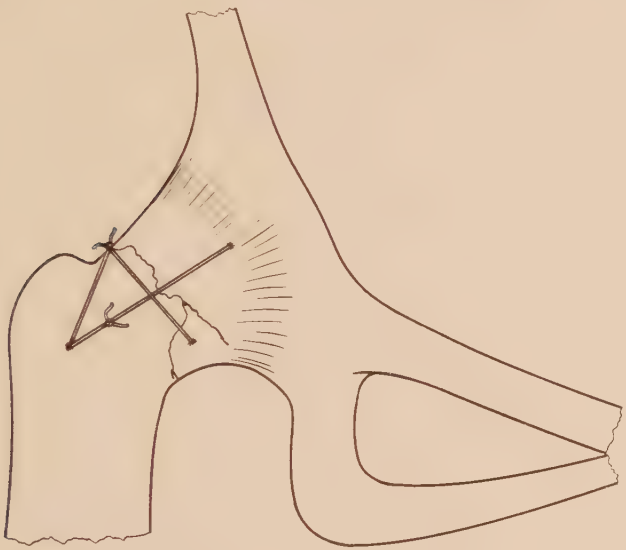

FIG. 6.—Diagram illustrating sutures stitching the divided capsule around the neck of a reduced femoral head in a congenital dislocation of the hip.

expected to overcome, as the surgeon learns the exact point for the insertion of the retaining sutures.

The choice of the retaining sutures (silk, chromicized catgut or kangaroo tendon) is one that will necessarily vary with the experience of different surgeons. The objection to silk sutures is that they will tend toward a limitation of the motion at the joint. The objection to other suture material, such as catgut or kangaroo tendon, is the possibility that they may be absorbed before the

retaining tissues have regained a sufficient amount of strength. These are matters which experience may be expected to settle.

Although the writer has performed the operation of reduction by incision in upward of fifty cases, the method here presented has only been performed in a dozen cases, and the statistics of the last twelve cases should be presented as indicating the value of the procedure. In these twelve cases the method was used only after the failure of the method of reduction by manipulative means.

A death is recorded from septicemia in one of the cases. The patient was three years old, and the operation was performed in a double congenital dislocation because of the impossibility of retaining the hip in its place, owing to the relaxation of the capsule. At the time of the incision a sufficiently large opening was found in the capsular ring for the introduction of the head, but it was impossible, owing to the laxity of the capsule, to retain the head in the acetabulum. The wound became contaminated in after-treatment, and violent sepsis followed, with death two weeks after the operation. The wound had been sewed up, and the result might have been different if an open wound had been left. The chief fault of the procedure in this instance was the attempt of an operation in so young a child. It was one of the youngest of the series.

In the other cases success was secured in eight, failure taking place in four. By failure is meant the non-retaining of the head firmly in the acetabulum. In two instances the mistake was made in the reduction after operation, in placing the head in such a position that it slipped downward below the acetabulum, and it was necessary by slight adduction of the limb to place the head nominally in the acetabulum.

An objection to the operation which suggests itself is the stiffness of the joint which might be supposed to follow. Some stiffness has followed in the more difficult cases, as is true in difficult cases treated by the method of forcible manipulation. How great the danger of stiffness the writer is as yet unable to determine. It is probable that the danger of permanent after-stiffness

is one which can be expected to diminish with increasing operative skill.

At present it must be admitted that the procedure is one which presents difficulties to the surgeon. The operation is not a light one, and involves a certain amount of risk. It is, however, believed that greater experience will diminish both the risk and the difficulty and increase the certainty of the method. As has already been said, the method of reduction by manipulation will in all probability remain the method of choice, but in event of failure, the method of excision can be relied on as offering the only remaining method of cure in such cases as present capsular obstruction to complete reduction.

The accompanying table may be of interest, as showing the improvement in the success following operations by incisions following improved methods:

Operations for Reduction of Congenital Dislocation of the Hip, at the Children's Hospital, Boston.

Date.	*Number of cases.*	*Success.*
1884 to 1896	21 cases	0
1896 to 1902	54 cases	
	20 incisions	1
	34 manipulations	11
1902	22 cases	
	2 incisions	0
	20 manipulations	8
1903	33 cases	
	2 incisions	0
	31 manipulations	11
1904–5	38 cases	
	17 incisions	14
	21 manipulations	10

Outside of hospital, 1 manipulation—death from accident two days after operation. 1 death from septicemia followed an operation for incision.

The method of capsule stitching is of use in the cases of loose disarticular hips which occasionally present themselves, following acute arthritis of infancy—two of the cases in this series were of this character. They were considered successful, though, owing to the previous absorption of the head and destruction of the bone, the result was not as good functionally as that following successful reduction of congenitally dislocated hips.

The substance of the subject may be stated briefly: In a large number of cases of congenital dislocation of the hip complete cure can be accomplished by manipulative reduction. In difficult cases efficient mechanical reduction is of assistance. In certain cases, owing to a distorted capsule, the femoral head is not placed deep in the acetabulum or is kept from the bottom of the acetabulum by a capsular fold and relapse takes place. Under these circumstances the surgeon can by incision of the capsule widen the capsular constriction, place the capsular flaps around the head and neck, secure the head of the femur until cicatrization has formed a retaining capsule about the reduced head.

The operation is a somewhat difficult one and is easily imperfectly done. It is a serious one, but is capable of giving most satisfactory results in cases where failure or imperfect result is otherwise inevitable.

DISCUSSION.

Dr. A. J. Ochsner, of Chicago.

I believe that this paper before this body of surgeons will have a very excellent effect because it shows the anatomical conditions before and after both forms of treatment. Personally, I have observed the manipulative treatment in some thirty selected cases, and in this series of cases there were but two joints in which it was possible to demonstrate the results by the anatomical specimen afterward. Both of these joints were in the same child, who died from some acute cause three years after a cure was effected, and in this case the conditions which have been pointed out existed, that is, the establishment of a practically normal joint. The skiagrams in many of the other cases showed equally perfect results.

This paper is valuable because it shows that the tendency which we had a few years ago, after the visit of Lorenz and some of his failures, of depending upon the open method and considering that method infallible, as compared with the manipulative method, was wrong. There can be no doubt from these demonstrations, and from the skiagrams of the cases I refer to, which were operated by my brother, that in thoroughly selected cases the results by manipulation are as good both anatomically and practically as by the other method. These children walk without a limp, and the skiagrams show that they have good joints. For the other class of cases, I believe Dr. Bradford's plan is to be followed.

Dr. M. L. Harris, of Chicago.

I wish to confirm the fact stated by Dr. Bradford of the insurmountable obstacle which contraction of the capsule between the head of the femur and the cavity will offer to manipulative reduction.

During Mr. Bartlett's visit to Chicago with his apparatus, I had a case of double congenital dislocation in the Children's Hospital which we had tried to reduce by manipulation and had failed. Mr. Bartlett brought the apparatus to the Hospital, and with it we made vigorous attempts to reduce the dislocations. We failed to do so. Mr. Bartlett thought he had gotten one side in, but it did not remain near where we wanted to keep it, nor was I convinced it was in. On the other side it was impossible to produce any effect whatsoever on the joint. After the child had recovered from the quite severe manipulative attempt, I cut down on the joint and found this constriction of the capsule just mentioned by Dr. Bradford, and only after dividing it with a bistoury,

which I did as he has mentioned, was I able to get the head back into the joint. It offered a complete obstacle to reduction in this case and the head could not have been reduced by any amount of force or manipulation. It is necessary to divide the capsule throughout its entire length, in these cases, in order to remove the constriction so that the head may enter the cavity.

Dr. Bradford. There is nothing which I can add except to repeat what I ventured to offer in the paper presented, which is in brief that while, in a majority of cases of congenitally dislocated hip, reduction by forcible manipulation can be successfully performed, in certain cases this is impossible owing to structural changes of the capsule at the mouth of the acetabulum. Where this is the case an incision is necessary and if this method is followed it is possible and advisable to utilize the capsule for the purpose of retaining the reduced head in place.

THE OPEN TREATMENT OF FRACTURES.

By EDWARD MARTIN, M.D.,
PHILADELPHIA.

It will be generally conceded by those having widest experience in the treatment of fracture that the rapidity, permanency, and completeness of cure are proportionate to the accuracy of reduction and retention, and that the great majority of simple fractures can be treated by splints and bandages, supplemented at times by extension, with completely satisfactory results. It will also be granted that even when reduction is imperfect and retention is inadequate, fractures, as a rule, unite firmly and are functionally satisfactory, though the resultant deformity be obvious or even gross. It is also true that even though the symptoms of interposition of soft parts between the ends of the broken bones are present, non-union is by no means an inevitable consequence of conservative treatment. It therefore follows that the cases of recent fracture uncomplicated by wounds which imperatively call for surgical intervention are extremely few.

These statements seem worth while, because of the enthusiastic advocacy of open treatment for all fractures in which reduction is not perfect on the part of a few surgeons who, having operated upon recent fractures, have obtained good results. These results in at least some instances have not been more satisfactory than such as might have been obtained by more conservative methods and with infinitely less risk to the patient. The wounds necessitated by the open treatment of fracture are more prone to suppurate than are those made in the performance of other operations. This partly because foreign bodies, often of considerable size, are buried in the wound, but mainly because, as a result of prolonged man-

ipulation and rough handling, and the use of tools ill adapted to the purpose, there is left at the end of operation a large amount of tissue so hopelessly devitalized that an abundant culture material is provided for even the slight infection whch inevitably takes place during the course of the most carefully conducted operation.

Of the many ingenious devices employed for permanently fixing broken bone ends in their proper relation to each other, chromicized catgut, wire, screws, and silver plates are the most serviceable. If the surgeon could be assured of a perfectly sterile No. 3 catgut so largely deprived of chromic acid as not to prove irritating to the tissues, this would be the material of choice in all cases where suture or encircling ligature is applicable.

Metal plates, screws, or wires are open to the objection that, even though the wound heal primarily over them, they remain always a potential cause of localizing infection. There are probably few here who, because of discharging sinuses, have not been compelled to remove foreign bodies from patients who had been reported by their colleagues as permanently healed. The liability of both early and late suppuration is in direct proportion to the size of the foreign body employed. Therefore, from the standpoint of permanency of healing, wire is preferable to either the plate or the screw, though it is by no means immune against late infection. It does not give either the fixation or, as a rule, the accurate coaptation of the latter. The silver wire usually employed is extremely prone to break either at the time of twisting or shortly after. *X*-ray photographs have abundantly shown the frequency of this accident. There is little reason to believe that it is less irritating than wire of other metals, and if a non-absorbable suture or ligature be chosen, phosphor bronze or delta metal, possessing equal suppleness and greater strength, should be employed, since thus a smaller caliber can be used.

Screws are extremely serviceable, in that they represent foreign bodies of moderate size, are readily applied, and will often hold bones in perfect apposition. They are especially applicable to the repair of oblique fractures of long bones. In fractures of the extremities of these bones, the cancellous tissue gives a grip

so feeble as to make their use of little service, unless driven through and through.

The proper application of a screw implies the selection of an almost cylindrical instrument with a deep thread cut clear to the head, and of such length as to pass completely through the bone at right angles to the line of fracture, but not beyond. Screws selected from the carpenter's tool-box, and the majority of those sold by surgical instrument makers, are ill adapted to the purposes of bone surgery, since the thread is lacking where it is most useful, and the pronounced conical shape greatly and uselessly increases the difficulty of driving the screw home.

The easy application of the screw is dependent on the proper selection of a drill and the use of a clamp so devised that the bones, having been placed in accurate apposition, are immovably held while the drill is being used and the screws are being driven home. The drill should be of such a size that it bores a hole through both fragments the full length of the screw, and of a diameter greater than its core.

When but one of the two fragments is adequately drilled, as the screw is driven in, it pushes the bones apart in place of bringing them together. The same result follows after having used the drill to a proper depth when the relation of the fragments to each other is changed; this frequently happens when the bones are

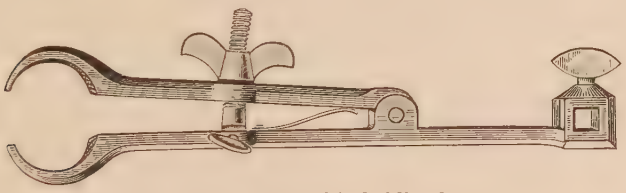

FIG. 1.—Clamp used in holding bone.

loosely held in the bottom of the wound by the fingers of an assistant. This should be obviated by the use of bone-clamps, which should be powerful enough to hold the largest bone in their grasp. One or two may be needful. Those I exhibit serve the purpose well, as do the forceps devised by Arbuthnot Lane.

The drilling should be done either by an electric or a foot engine. The use of any other instrument is not only awkward and time-consuming, but exposes the patient to the danger of serious trauma. When wire or gut is to be passed through drill-holes, the instrument should be provided with an eye near its cutting end, through which, when it has been driven completely through the bone, can be passed a guiding thread. McCurdy accomplishes the same purpose by a notch placed just above the end of the instrument.

The silver plate finds its most useful application in transverse fractures. Its proper fitting is made by the use of grasping instruments, which not only hold the two bones in accurate apposition one with the other, but also secure the plate firmly in place while the holes are being bored and the screws applied. The starting of the screws in the drill-holes, particularly in the treatment of broken small bones, such as the ulna, clavicle, or fibula, or when the fragments to be held in apposition lie at the bottom of a deep wound, is greatly facilitated by a screwdriver which firmly holds the screw in a jaw devised for the purpose until it is fixed in its drill-hole. Such an instrument I exhibit.

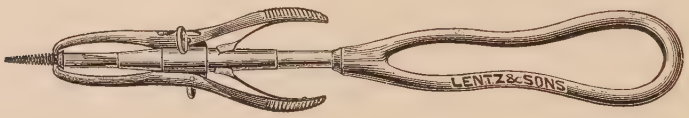

FIG. 2.—Special screwdriver.

As to the simple fractures which require treatment by immediate operation, all such as present an irreducible deformity so great as manifestly to interfere with function, even though union take place, should be treated through an incision. This rule applies to every accessible bone in the body.

The fractures which most commonly require open treatment are those of the patella, olecranon, clavicle, the humerus, particularly its extremities, femur, the tibia, and fibula.

It is probable that in fracture of the anatomical neck of the humerus, or of the head or neck of the femur, or of the astragalus,

FIG. 1.—L. E. Comminuted fracture of lower end of humerus. Before wiring.

FIG. 2.—L. E Comminuted fracture of lower end of humerus. Before wiring.
FIG. 3.—J. B. Compound comminuted fracture of both bones of leg. Ten months after plating. Functional and cosmetic results perfect.

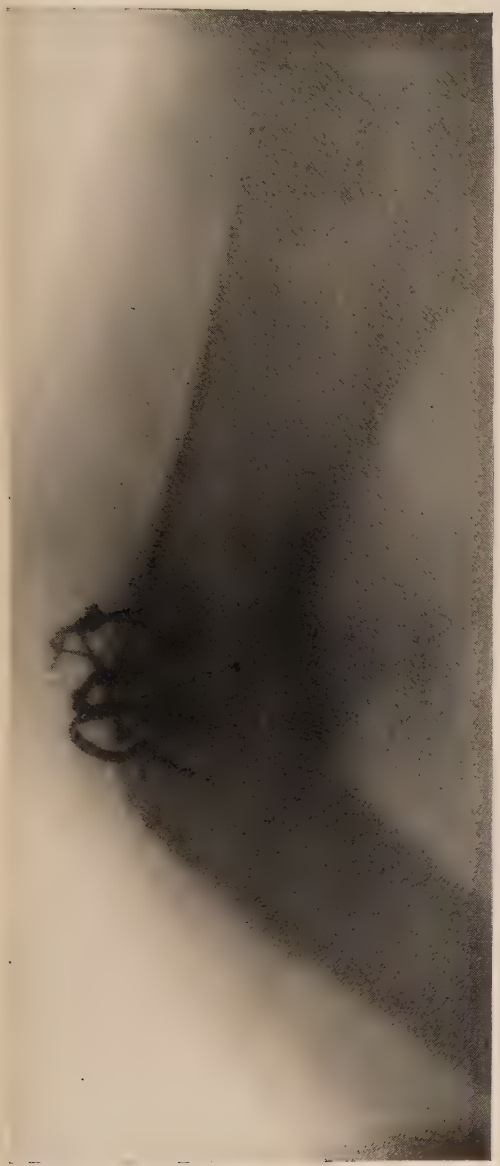

FIG. 4.—Wiring of transverse fracture of femur. Bad result. (Surgeon unnamed.)
FIG. 5.—Fracture of humerus. Before wiring.

FIG. 6.—Recent fracture styloid. Showing plate put in seven years before, by John Ashhurst, for compound fracture of radius.

FIG. 7.—Recent fracture styloid. Compound fracture plated seven years ago. Necrosis of ulna. (John Ashhurst.)

FIG. 8.—Showing type of screw.

FIG. 9.—L. E. Comminuted fracture. Lower end of humerus. After wiring.

FIG. 10.—J. B. Compound comminuted fracture of tibia and fibula. Before plating.

FIG. 11.—Mrs. Y. Showing high fracture of fibula and tibia spiral fracture.

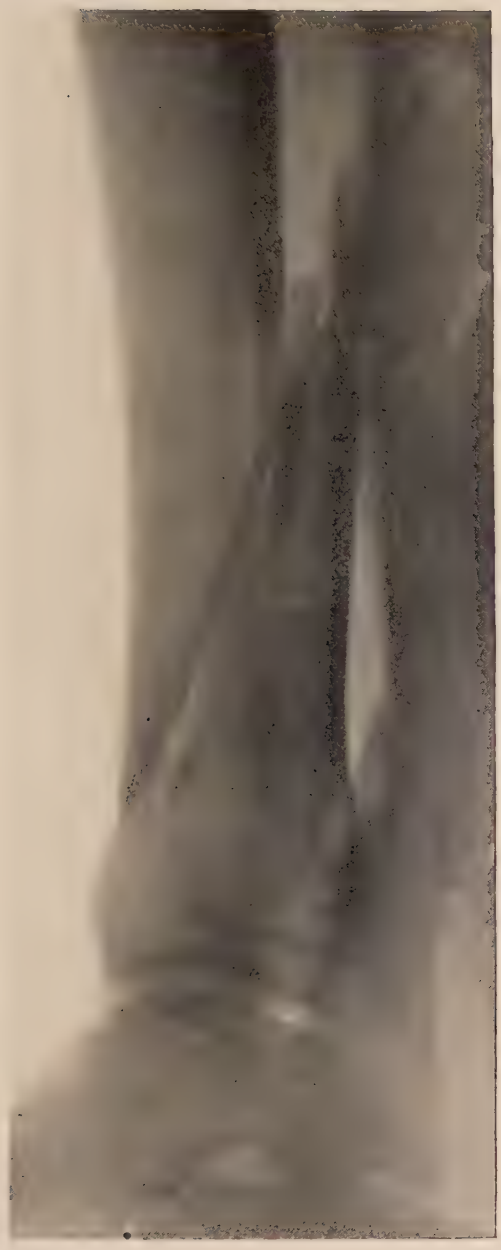

FIG. 12.—J. B. Compound comminuted fracture of tibia and fibula. Before plating.

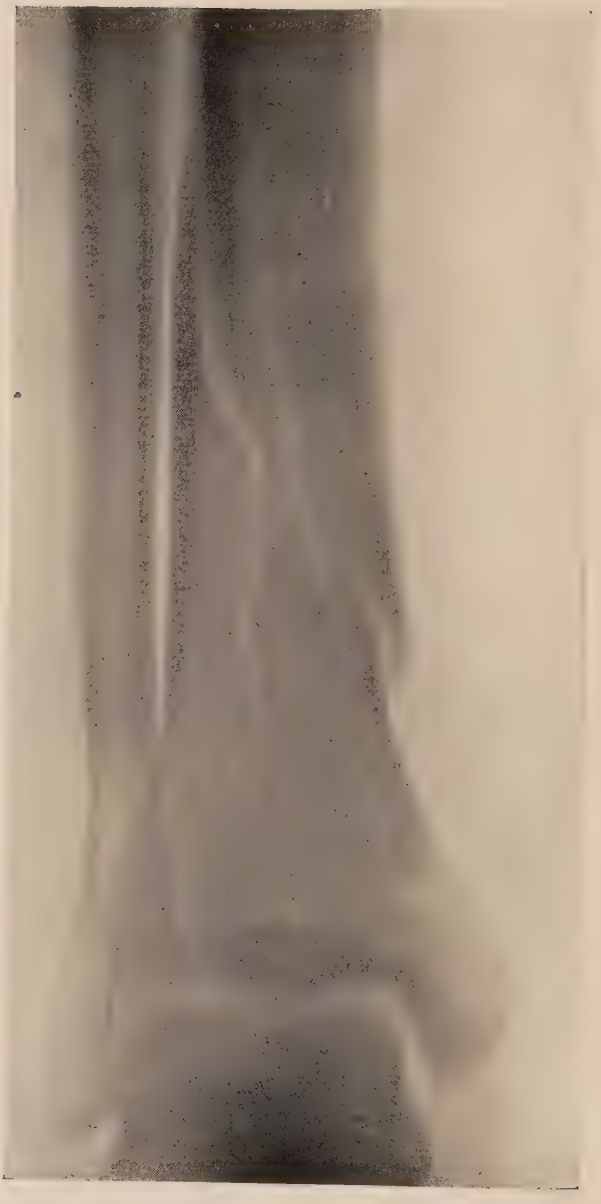

FIG. 13.—Spiral fracture of tibia. Seven weeks after the accident. Good result by splinting.

FIG. 15.—J. B. Compound comminuted fracture of both bones of leg. Before plating.

FIG. 16.—Comminuted fracture of femur. Suited to plating and wiring

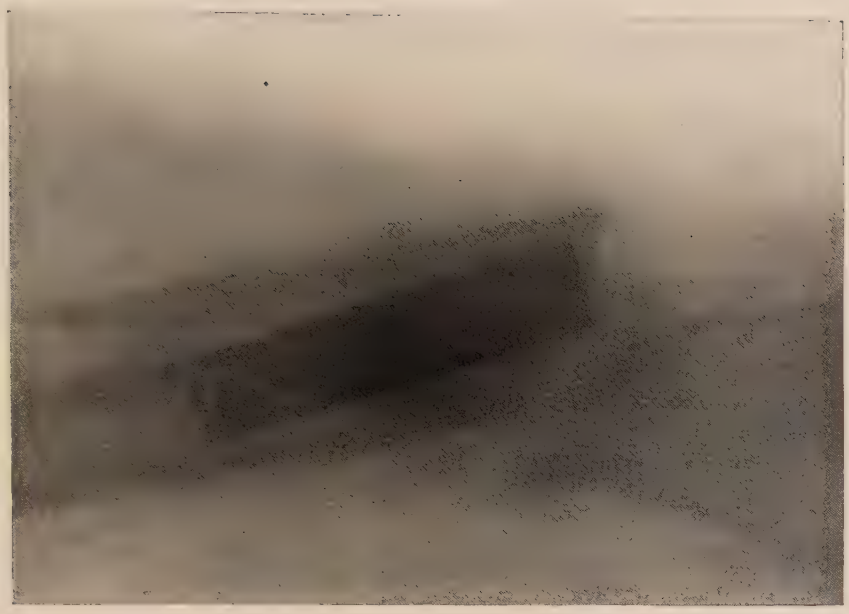

FIG. 17.—Plating for delayed union of transverse fracture of femur. Result bad. (Surgeon unknown.)

FIG. 18.—Transverse fracture of right femur. Nine months after wiring. (Surgeon unknown.)

FIG. 19.—Mrs. Y. Spiral fracture of tibia. Fibula broken high up. Six weeks after plating.

FIG. 20.—Compound fracture of tibia and fibula. After removing plate. (Cornett.)

FIG. 21.—Mrs. Y. Spiral fracture of tibia. Before plating. Shortening one inch.

FIG. 22.—E. V. Fracture of neck of humerus. Before wiring.

Fig. 23—Compound fracture of tibia and fibula. Showing plate. (Cornett.)

FIG. 24.—E. V. Fracture of surgical neck of humerus. After wiring. Result bad. (Surgeon unnamed.)

Fig. 25.—Fracture of astragalus, with subluxation. Crippled ankle.

excision will give better results than any of the operative methods of apposition thus far proposed.

In fractures of the malleoli, provided they be uncomplicated by injuries of the tarsal bones or chipping of the articular surface of the tibia, complete reduction and retention are readily accomplished and the functional results are admirable.

It is probable that all the cases of hopeless crippling which follow injuries diagnosed as malleolar fracture are in reality due to injury to the astragalus, os calcis, or articular extremity of the tibia, thus allowing such alteration in the plantar arches, or the application of the body weight to them, that atrophic changes and pain and tenderness on use are progressive. That some of these cases might be benefited by suturing operation seems probable, though I am not aware that this procedure has been practised, excepting for the cure of fracture of the greater tuberosity of the calcaneum.

The operative measures devised and practised for the cure of fracture of the femoral neck seem, from the purely mechanical standpoint, inadequate, nor do the clinical results of the procedures justify their acceptance upon the part of the profession. Perhaps the commonest method of coaptation is to drive a nail or screw through the base of the trochanter into the neck and head of the bone, in the hope that thus the fragments may be held in their normal relation one to the other till healing takes place. The soft structure of the femoral head and neck affords but a feeble hold to an instrument thus driven into it, and one totally inadequate to combat the tendency to shortening, angulation, and rotation incident to the action of the powerful pelvic and thigh muscles. If approximation and retention are to be accomplished by instrumental means, it must be through the agency of a screw at least six inches in length, entered two inches below the trochanter, driven up through the neck and head of the bone and into the pelvis while the fracture is completely reduced under ether.

Ruth and Whitman, have, however, so clearly demonstrated that union in good position may be secured by proper conservative

treatment of these fractures, that the profession is likely to be less concerned with their open treatment than in the past.

As to the selection of the individual method of holding bones which cannot be placed in proper relation to each other without operation, the incision should be a free one, and should be made as soon after the infliction of the injury as it can be determined that reposition is possible by no other method. This insures the clearing away of blood-clots, which are often factors in increasing separation and preventing reduction.

Comminuted fractures of the shafts of long bones are best secured by wrapping with silver wire, supplemented by the application of screws or silver plates, in the absence of devitalizing lesions of the soft parts. There seems no reason for the sacrifice of any fragment which can be reduced and retained in accordance with the mechanical requirements of the case.

In oblique fractures, two screws driven in at right angles to the line of fracture, of such length as to pass completely through the bone, should prove adequate. The apposition may be made still firmer by one or two encircling gut or wire ligatures.

In transverse fractures of the shafts of the long bones the silver plate has its chief applicability.

In fractures involving joint surfaces and the soft structures of ends of bones the catgut or wire suture would seem most serviceable. Intercondylar fractures may be best treated by the application of a rod provided with a nut at each end, such as I exhibit. In one such case I transfixed with silver wire and maintained apposition by lead shot clamped in place when the broken bones were brought in apposition.

As to the preparation for the open treatment of fracture, the surgeon should be provided with rubber gloves of extra thickness, with screws of varying length, cylindrical or very slightly conical, and threaded to the head; with either an electrical or foot engine, which will enable him to apply his drills with accuracy and the expenditure of a minimum amount of force; with drills adapted to the varying diameter and length of the screws to be used; with clamps or forceps which will hold the bones in accurate

apposition; with wire of adequate tensile strength and varying sizes; with a screwdriver which can be easily manipulated and which holds the screws until they are well started; and with silver plates.

A more important provision than any of these is a thorough training in cleanliness on the part of the surgeon, a realization of the disastrous results which will almost certainly follow infection, and the avoidance of an operation until such time as not only the proper tools, but also trained assistants and a well-organized aseptic technique, can be provided. The open treatment of simple fracture cannot be regarded as an emergency operation.

DISCUSSION.

Dr. W. W. Keen, of Philadelphia.

A word in reference to one fracture alluded to by Dr. Martin and unfortunately I must take exception to one method of treatment. As to fracture of the neck of the femur, I have only had one case of ununited fracture of this kind in a comparatively young person, the result of traumatism, in which I used a screw. Dr. Martin urges the use of a screw six inches in length, driven not only through the two fragments of the femur, but into the pelvis. To this I object, because it would be followed by a rigid joint at the hip. In my own case I was careful, after measuring the parts on an *x*-ray picture, to select an ordinary screw three inches long, which when countersunk reached from the great trochanter nearly through the head of the bone, but not into and invading the joint. When I last heard from the patient, the result was satisfactory. She was able then to walk about without either the aid of a crutch or a cane. The operation consisted of making two incisions, one in front down to the capsule, opening the capsule, chiseling the two ends of the bone so as to make a fresh raw surface, because the fracture was an old one, and then a second incision over the great trochanter through which the screws were inserted.

Dr. Leonard Freeman, of Denver.

Dr. Martin has not mentioned the use of external clamps, the efficiency of which in ununited fractures was emphasized in this Association by Dr. Parkhill some time ago, and I wish to speak of them in connection with recent fractures. I have a clamp devised upon the same principle as that of Dr. Parkhill, but which is decidedly different in its construction and much more simple. I have had occasion to use this clamp in the treatment of certain recent fractures. I agree heartily with Dr. Martin that the best method of treating recent fractures is not by the open method; but every once in a while we come across an oblique fracture which it is almost impossible to hold by splints, and rather than let such a fracture produce deformity it is better to cut down upon it. Sometimes it can be held satisfactorily by wire or by catgut suture. If this can be done, it is without doubt the best procedure; but, there are cases which cannot readily be held with wire, and in which, in order to insert wire, we have to strip up the periosteum and use a great deal of mutilating manipulation In such cases the external clamp is of great service. It may be objected to on the ground that infection is liable to take place. I do not think this objection holds.

My experience is that infection does not take place very rapidly through the openings in which the screws are inserted, and if it does finally occur the surroundings are so thoroughly protected by adhesions and lymph that no material damage results and recovery rapidly follows removal of the screws.

The clamp I use is an extremely simple one, and I present it to you on account of its convenience, effectiveness, and simplicity. It consists of four separate screws inserted through holes made by a bone-drill. I do not agree with Dr. Martin that a dental drill is necessary. Ordinarily the Langenbeck drill serves the purpose very well. These screws are inserted as nearly as possible in an exact line with each other, but if the line is not exact it is not of much importance. The screws are held together by two side-clamps lined with wood and tightened by thumb-screws. The essential point in the whole mechanism is the wood which lines the side-clamps. These pieces of wood hold the screws much more firmly than could the metal alone. This clamp can be used in ununited fractures, in recent fractures, or in ununited fractures of the hip-joint, using one long screw to go through the trochanter and head of the bone, and placing two other screws in the femur below the trochanter, thus securing perfect solidity. By means of the wood the upper screw can be placed in any position which cannot be done with the Parkhill clamp. (An illustration of this clamp is to be found in *Annals of Surgery*, 1904.)

Dr. Joseph C. Bloodgood, of Baltimore.

In reference to the operative treatment of fractures presented by Dr. Martin, I should like to call attention to the recent contribution of Fritz König (*Archiv. f. klin. Chir.*, 1905, vol. lxxvi, p. 725). König is of the opinion that non-union in intracapsular fracture of the neck of the femur is not so much the fault of the non-apposition of the bone fragments as of the interrupted circulation in the head fragment due to the tear in the capsule. His investigations demonstrate that in the operative treatment of this fracture not only the bones but the torn capsule should be approximated by suture.

I take this opportunity to call attention to the importance of position in reducing certain fractures and in maintaining this position. Some years ago I observed a spiral fracture of the shaft of the humerus in a physician. *X*-ray examinations of the arm after reduction, but not in the abducted position, demonstrated that the fragments were still widely separated. For this reason they were exposed by open incision. Now, when the arm was fully abducted the fragments spontaneously fell into position. They were not wired, but held in place by Middeldorpf's triangular splint.

Royal Whitman's suggestion that fractures of the neck of the femur should be reduced under anesthesia by forced abduction and maintained in this position in a plaster dressing is distinctly worthy of trial by all surgeons.

In the so-called open treatment of recent fractures it appears to me that the chief indication for the operation is the reduction of the dislocations at the site of fracture. Fixation by suture is not always necessary. When this is required some form of buried suture should be employed. I thoroughly agree with Dr. Martin that better results will be accomplished if the surgeon improves his armamentarium.

Dr. Martin. Dr. Keen slightly misunderstood me when he made the statement that I advocated the use of a six-inch screw, driven into the pelvis. From a mechanical standpoint, this seems the only adequate way of holding the broken bones or fragments in position. Though some of the cases of comparatively short screws driven through the head and neck of the femur and into its head for the holding of the fragments in apposition may have resulted in union, this was in a position of coxa vara, rather leaving a condition almost as bad as would have resulted from non-union. There is no reason to suppose that a short screw can hold the bones unless extension be carried out absolutely and continuously to correct the deformity.

In regard to the use of plates and screws, and the particular form of drill, it is true that a man in a broken automobile may be able to mend his machine by means of a hairpin and adhesive plaster, but he will do it better and quicker it he has the proper tools to work with. The most adverse criticism which can be made against the operative treatment of fracture is incident not to lack of skill, but to the use of tools that are not suited to this purpose.

In regard to the remarks made by Dr. Bloodgood, with reference to the abducted position in the treatment of high fracture of the humerus, this was taught by Dr. Agnew and has been applied by many of his pupils.

SOME EXPERIENCES IN THE OPERATION OF THYROIDECTOMY, PARTIAL AND COMPLETE.

By FRANCIS J. SHEPHERD, M.D.,
MONTREAL, CANADA.

My first operation on the thyroid was in 1883, my next in 1889, and in both cases enucleation of the tumor, which as usual was on the right side, was performed. In each case the tumor was cysticocolloid in character. At this time I was much influenced by the work of Professor Socin, who advocated enucleation of the tumor in preference to excision of part of the gland itself. The advantages claimed for this method are: (1) Rapidity and comparative bloodlessness of the operation. (2) The fact that only the diseased portion of the gland is removed, so that no danger can be feared of such after-results as cachexia strumipriva, etc. (3) The comparative safety of the method and the absence of risk of wounding the recurrent laryngeal nerve.

In my first twenty-five cases I practised no other method for simple cystic and adenomatous goitres, and was delighted with the good and speedy results. But, alas, a case of secondary hemorrhage occurred, which nearly lost me my patient; and a little later another patient had secondary hemorrhage, which almost terminated her existence, and had not the cavity been immediately opened, the blood-clot removed, and the inside packed with gauze soaked in tincture of iron, a fatal result would have ensued. These two cases alarmed me, and after this I rarely enucleated the tumor, except in cases of simple cysts, but removed the half or all the gland which contained the tumors. Another reason for my abandoning enucleation as a routine method was

the fact that in some cases I had recurrences of the cyst or tumor, and the operation had to be repeated.

About 1897–98 I commenced to remove more frequently the whole or part of the thyroid. Simple cases now I did not see so often, but the large solid growths with difficult respiration and perhaps swallowing, with nervous symptoms and rapid pulse beginning to appear. I was really forced to give up enucleation, because, as I said, now more difficult cases were sent me; the simpler ones were treated elsewhere.

PARALYSIS AND INJURY OF NERVES.

In the twenty years and more during which I have operated on enlarged thyroids (in the neighborhood of one hundred cases) I have only once cut the recurrent laryngeal nerve, and in this case the tumor was of enormous size, and had been treated in England by the actual cautery and the plunging in of pieces of caustic potash, so that there was much cicatricial tissue. In this case no harm resulted, for the other nerve was intact. The nerve was sutured immediately and in a few months recovered its function. In another case, where there was existing paralysis of the left nerve and the tumor was of large size, in fact where the disease was so extensive that the whole gland had to be removed, just as I was sewing up the wound a spurt of blood came from the right side of the larynx, and I seized the bleeding-point with a pair of artery-forceps; immediately the breathing became noisy, expiration was easy, but on inspiration there was aspiration of the cords and a peculiar inspiratory whistle produced; inspiration was so difficult and breathing so labored that tracheotomy had to be performed (the forceps had been removed as soon as the peculiar breathing appeared). After a week, voice was partially recovered, the tube removed, and in two weeks she left the hospital with as good a voice as before she entered it. In this case the left cord was paralyzed, and I probably seized some small branch of the recurrent going to the abductors, so the adductors had nothing to oppose them and the rima was closed.

It is quite common in large thyroids to find paralysis of one cord. I have never seen paralysis of both, but one cord is not uncommonly paralyzed from pressure, either partially or wholly, and atrophy may cause the loss of function. In my experience the left cord is most commonly affected, and this occurs especially when the largest growth is on the right side. It is always important that the larynx should be examined before operation, for if one cord is paralyzed the operator will necessarily be more careful not to injure the nerve of the other side. In cases where one cord is paralyzed, the cord of the other side may move over to the affected side and so compensate, and very little change will be noticed in the voice, except that the patient tires easily on talking. In some cases there is merely irritation of the nerve. This produces fits and spasms of coughing, and especially is this so on any unusual exertion.

In all cases of cord paralysis it is the abductors that are first affected. After the removal of the tumor, the nerve partially or completely recovers its function. Where the cord has been immobile for months, a few days after removal of the tumor it begins to move, and in a month has recovered a considerable portion of its former function, provided, of course, the paralysis is a pressure and no atrophy has taken place.

HEMORRHAGE.

I have had a few cases where there was considerable hemorrhage due to tearing of large veins on the surface of the tumor. If the bleeding is very free, it is a waste of time to try and secure the bleeding veins by forceps, for the veins are so friable that the more they are seized the more they tear and the greater the bleeding. In such cases I rapidly turn out the whole gland of that side and secure the superior and inferior thyroid arteries; then the bleeding ceases; in fact, as soon as the gland is turned out, the vessels can be seized and hemorrhage stops, and the rest of the operation is simple. In a case of cystic thyroid, which afterward proved to be malignant, in trying to enucleate the largest cyst it was acci-

dentally broken, and the most frightful hemorrhage ensued, almost as if I had broken into a large venous sinus. The rapid delivery of the whole gland and the securing of the vessel enabled me to arrest the hemorrhage before a fatal result ensued. Salines had to be injected, and finally a good recovery was made, but a few months afterward the patient died of malignant disease, which had involved the lungs.

ANOMALOUS POSITION OF THE GLAND.

In two cases, sisters, where the breadth of the goitre was greater than its depth, the gland was shaped like a huge pair of horns, the end of each cornu almost touching behind and surrounding the trachea and œsophagus. The dissection of the upper horns was difficult. In this form of "circular goitre" there is nearly always difficulty in breathing and swallowing. In another case of left-sided goitre in an elderly woman, she demanded the operation because she had such great difficulty in swallowing. On operating, I found the trachea pushed to the right, and the œsophagus coming over the left side of the tumor and quite superficial; the tumor appeared to have grown to the left side, between the trachea and œsophagus. After removal of the tumor, the œsophagus for some distance was quite free, for it had been dissected away from the tumor, and it seemed to be much too long for the neck when freed from the enlarged thyroid. However, in a short time swallowing was performed as easily as ever, and the patient went home well in ten days.

Cases where most of the tumor is retrosternal are often very difficult, the separation of the gland from the large inferior thyroid veins being a matter of some difficulty. In one case nearly the whole transverse innominate vein was exposed. In these cases there is danger, when secondary hemorrhage occurs, of bleeding taking place into the mediastinum.

I have had only one case of accessory thyroid, and this was beneath the left sternomastoid, and it was affected with malignant disease.

In some cases of enlarged thyroid, owing to inflammatory adhesions, there is difficulty in dissecting out the gland; the tumor does not "shell out," as is usually the way, but has to be actually dissected, thus prolonging the operation and increasing the risk.

INDICATIONS FOR OPERATION.

The indications I have considered to justify operation in simple goiters are: (1) Progressively increasing size of tumor. (2) Rapid growth, with dyspnœa on exertion or when bending forward, attacks of difficult breathing coming on paroxysmally. (3) Narrowing of trachea. (4) Difficulty in swallowing. (5) Alteration of voice. (6) Tachycardia and nervousness, coming on perhaps after years of no inconvenience, caused by the enlargement. (7) Inconvenience and deformity, due to the size of the growth.

Billroth was of opinion that no operation should be performed after forty, unless there was malignant disease. This I cannot agree with.

ANESTHESIA.

When I first commenced operating I used chloroform, but a death occurring in the practice of one of my colleagues from this anesthetic, I changed to ether. I found this anesthetic caused so much venous congestion, and so much mucus collected in the throat, that for several years past I have used a mixture of ether and chloroform with good results. So far, I have had no death and no alarming symptoms from general anesthesia, and have not felt inclined to adopt local anesthesia. I have tried to induce patients to be operated by local anesthesia, but usually before commencing the operation they have begged for ether or chloroform. Most of the advanced cases are very nervous, and operating under local anesthesia is not the most agreeable thing, either for the operator or the patient. I, for my part, feel much more comfortable when the patient is unconscious. Before operating I induce full anesthesia, and toward the end of the operation do

not require or desire such profound unconsciousness. In these cases I think it very important not to handle the recurrent nerve or to pull on it. This, on one occasion, when I was helping a colleague, caused considerable shock, and death ensued, which was attributed to the anesthetic. I think the danger from general

FIG. 1.—Symmetrical enlargement of gland. The upper cornua almost meet posteriorly.

anesthesia has been much exaggerated, and with care on the part of the operator and the anesthetist, I do not think much risk is run. I am sure in a few years all thyroidectomies will be again done under general anesthesia.

MALIGNANT CASES.

During the past twenty years I have operated on seven cases of carcinoma, and all but one have died; this one I operated on no fewer than three times; the last time, some four years ago, for recurrence of the disease in the glands of the neck. On this

FIG. 2.—Enlarged gland in woman aged sixty years. Tumor grew between trachea and œsophagus, the latter being superficial.

occasion I took everything away on that side of the neck, including the carotid artery, jugular vein, and vagus nerve. After the second operation she developed myxœdema, and has now to be constantly fed with thyroid. She is in excellent health and shows no sign of recurrence. In two cases in which I operated to

relieve swallowing and breathing, the patients lived only a short time after operation. In another case there was an enormous cyst, which was removed, filled with blood. The man made a rapid recovery, but a few months afterward began to spit blood. The cyst was now examined microscopically for the first time, and found to be cancerous, though, at operation, from the clinical

FIG. 3.—Case of malignant disease of thyroid. Recurrence in the lung some months after removal.

appearances there was no suspicion of malignant disease. The man died a short time after this, from cancer of the lung.

I quite agree with Bloodgood, who holds that when carcinoma infiltrates no cure follows extirpation, and he further advises a very

wise procedure, namely, that every asymmetrical enlargement of the thyroid in individuals over thirty years of age should be subjected to operative removal. In this way, carcinomatous tumors are removed at periods when, clinically, they cannot be differentiated from simple cysts or adenomata, and in this way the removal of an apparently innocent growth may be an early extir-

FIG. 4.—Enlarged thyroid, cysticocolloid in character, lasting for years. The left cord was paralyzed

pation of a carcinoma. Kocher says, and I can corroborate his statement, that if the patient has suffered from a simple goitre for many years, a sudden enlargement may indicate the possibility of malignant change, and operation should at once be performed. This sudden enlargement may be due to hemorrhage.

MORTALITY.

Before the days of antiseptic surgery the operation of thyroidectomy was looked upon with dread, and the mortality was very high, from sepsis, hemorrhage, and pneumonia, also tetany and

FIG. 5.—Same as Fig. 4. Showing the curved incision used in cases of very large thyroid. Photograph taken a week after operation.

myxœdema. With the introduction of modern antiseptic surgery and improved methods for arresting hemorrhage, the mortality in cases of simple goitres has been reduced to a very small percentage. Kocher had no mortality in 272 consecutive cases;

Kronlein, in 200; Roux, in 526 operations, had a mortality of 11.27 per cent.; and von Mikulicz, in 151, had 2.6 per cent. Reverdin's statistics of 6,103 operations gave a mortality of 2.88 per cent.: the cause of death being, from operation, 93; suffocation, asphyxia, or pneumonia, 42; hemorrhage, 19; wound infection, 13; wounds of laryngeals, 9; syncope, 4; myxœdema and tetany, 4. I have seen one case of pneumonia following operation, but the patient recovered.

METHOD OF OPERATION.

I have always used the vertical incision to remove thyroids. In very large ones I extend the incision in a curved manner, with the concavity upward to the opposite side, a little above the suprasternal notch, but in ordinary cases a longitudinal incision along the inner border of the sternomastoid muscle I have found quite sufficient. The transverse incision I have tried and given up. I do not find it as convenient as the vertical.

After tying all superficial vessels and cutting through or pulling aside the omohyoid, the gland is come down upon; I now clear the upper end, ligate the superior thyroid artery and vein, and then deliver the tumor, the freeing of the upper cornu making this much easier. I now look for the inferior thyroid artery, secure it before it divides, and then look for the recurrent nerve, which is usually easily found running up the side of the trachea; the branches of the artery and the middle thyroid veins are now tied and cut internal to the nerve, and the inferior thyroid veins also secured and cut, and the gland separated from the trachea, the isthmus secured with a Kocher clamp and then tied off. If the whole gland is to be removed, the opposite side can be easily turned out through the same incision, and the vessels secured as before, the removal of the largest half facilitating the enucleation of the other. The wound is closed, after all hemorrhage is controlled, with horsehair sutures, and a small drainage-tube or cigarette drain introduced; this is left in twenty-four hours. Since giving up subcutaneous sutures I now rarely see keloid.

When the fascia has been cut through and the muscles separated,

it is of the utmost importance to recognize the capsule of the gland, its peculiar bluish-red color, with numbers of small and distended veins running over it, making it possible to identify it, and with practice it is easy. It is important not to cut into the capsule, for if this be done, profuse and often alarming hemorrhage occurs. In separating the tumor, great care is necessary. I prefer my finger, but some use a blunt instrument. I never, as I said before, deliver the tumor before tying and cutting away the superior thyroid vessels. It is most important to secure the inferior thyroid artery immediately after delivery of lower part of gland.

High temperatures after operation are common, 60 to 80 per cent.; thought to be due to too great handling of the gland. Difficult breathing after operation ought to be carefully inquired into; it may be due to hemorrhage, accumulation of mucus, too tight dressings, and also the packing enlarging owing to its becoming soaked with blood or exudate. Pneumonia may follow operation, though I have seen only one case. There is usually painful deglutition after operation, but this soon passes off.

It has been my habit, when the disease involves the whole gland, to leave a small portion which lies on the trachea near where the superior thyroid artery enters, but sometimes I have not been able to leave any part of the gland, and yet in only one case have I seen myxœdema follow operation. In many cases of large multilocular cysts I tied and cut away the superior thyroid vessels, then delivered the gland and enucleated the tumor. This leaves a thin layer of gland tissue behind, and there is no danger of injuring the recurrent nerve. Sometimes I tie the inferior thyroid as well. It is astonishing the facility with which the tumor is shelled out by this method, and of course with no hemorrhage. I sometimes pack the cavity for twenty-four hours with iodoform. gauze. This I have found beneficial; it precludes the danger of hemorrhage, and I think lessens the tendency to thyroidism. I occasionally use a drain only, cigarette or rubber, and never close the wound entirely. I always remove the drainage and packing on the day after the operation.

I have never yet lost a case of simple goitre, but two exophthalmic

cases have died. I have had only one case of myxœdema following excision of the whole thyroid, and this was the case of malignant disease, mentioned above, which recurred. The dangers of the operation are known to you all—shock, injury to the recurrents, hemorrhage, infection, pneumonia, heart failure, etc. In only one case have I had to perform tracheotomy, and the tube was removed in one week, the patient recovering as related above.

As I intend shortly to read a paper on the surgical treatment of exophthalmic goitre, I have not mentioned my experiences in this form of goitre.

DISCUSSION.

Dr. Willis G. Macdonald, of Albany.

I wish to speak of a single point with relation to the paper just read, namely, the question of the character and kind of anesthesia which is to be employed in such cases. In the immediate neighborhood of Albany in the past three years three patients at least have died on the table from the effects of general anesthesia during attempts to remove thyroids. The only patient I ever lost in attempting to do a thyroidectomy I lost from ether anesthesia. For the last five years practically a very small percentage of my patients have received any general anesthetic. A considerable proportion of cases upon which I have operated have been cases of exophthalmic goitre in which I have removed practically two-thirds of the gland, taking the largest size, ligating the superior and inferior thyroid on that side, and the superior thyroid on the opposite side. In scarcely 10 per cent. of the cases I have been obliged to give a general anesthetic, and under such circumstances it has been chloroform and oxygen.

The plan employed has been usually to discuss frankly and freely with patients, from my standpoint at least, the dangers of general anesthesia in doing thyroidectomy; to secure their consent and co-operation. Half an hour before the operation is undertaken the patient is given 1/4 of a grain of morphine, and 1/150 of a grain of atropia. When the patient is placed upon the table, a compound solution of 0.5 of 1 per cent. cocaine, with one to fifteen or twenty thousandth of adrenalin chloride has been used. Whenever I use the ordinary incision of Kocher, about thirty minims is used, as a rule, which allows you to expose the gland. After having exposed the gland, you can use a solution of one-half that strength, that is, 0.4 per cent. Besides the relief of all anxieties of general anesthesia, it has another and a peculiar advantage which I hold, namely, that when we operate under local anesthesia we will never injure the recurrent laryngeal nerve, or if we do injure it a little, we let loose very quickly on account of the symptoms which are produced. I think it is an extremely difficult thing under general anesthesia to avoid the recurrent laryngeal nerve, particularly on the right side, when we make an effort to ligate the inferior thyroid artery. In my experience, in the cases upon which I have operated I never have yet seized, sewed or in any way injured the recurrent laryngeal nerve on the left side of the neck, but on several occasions I have had hold of it; when I used general anesthesia I have definitely injured it, and more recently I have had occasion more than once to take off the artery clamp when I seized the inferior thyroid artery on the right side.

Dr. Roswell Park, of Buffalo.

It seems to me it should not be forgotten that the most important addition to the technique of this operation in late years has emanated from this city, and that is the suggestion of Dr. Crile, and it is a pity not to mention it here. I refer to the use of the pneumatic suit which he has devised and the semivertical position of the patient by which the veins of the neck are kept well drained, and by which, at the same time, blood pressure is maintained to any desired degree. Ever since I have learned his method of doing it I have resorted to it constantly, and I would not undertake now a goitre operation without the use of the pneumatic suit and that position.

Dr. Charles H. Mayo, of Rochester.

This is a most interesting subject to me. I have operated on 232 goitres, of which 85 were exophthalmic. I have had one death out of the entire number from pneumonia, occurring on the eighth day after operation, excluding, of course, the exophthalmics, carcinoma and sarcoma. While it is possible that we may lose through serum-therapy some of the work on the exophthalmic cases, I do not believe so myself, although it is so reported in recent medical literature.

In exophthalmic goitre the essential feature is a hypertrophy. There is an increase of cell material. Instead of there being one layer lining the acini, we have as many as four layers. Instead of lining it evenly to get more cells, it unfolds like the cortex of the brain, so that we have a little or no colloid and a typical change in the gland. It is unnecessary that every case should have the thyroid change, so that there is hypertrophy of every part of the gland, but we must have hypertrophic areas. In many of the cases there are scattered areas of hypertrophy. Many of the patients have had goitre for some years previously, and such cases have been dreaded by physicians because they have exaggerated symptoms. They treat such cases without having any idea of making a pathological or microscopical diagnosis, yet placing the cases on record as instances of true exophthalmic goitre.

I was glad to hear what was said with reference to general anesthesia. In the 232 cases I have previously mentioned I used cocaine anesthesia 13 times, and in 3 of these completed the operation under chloroform. In the last 150 cases I used ether. You avoid all of the bronchial irritation by giving them hypodermically 1/120 of a grain of atropine with morphine twenty minutes before operation.

Sometimes, after losing a patient a surgeon might make use of the pneumatic suit or some mechanical contrivance in a case in which there was a great feeling of responsibility, thus dividing that responsibility with the mechanical contrivance and his own work. I do not find it

necessary to do any more than elevate the patient. In 85 cases of exophthalmic goitre I lost 4 in the first 16, and in the next list of 28, I lost 3. I have not had a death since. These were bad cases. I have the records of them to be published soon.

As to the parathyroids, I have removed forty-eight goitres since the first of the year, and I have found three parathyroids removed at the base of the goitre. I once did not see them, but I see them now, and I find them in the base of the gland occasionally.

Dr. W. W. Keen, of Philadelphia.

I would like to ask Dr. Mayo how he finds the parathyroids? I have in every case within the last year or two looked and endeavored to the best of my ability to see them, but have not succeeded in doing so once either at the operation or in examining the specimen afterward.

Dr. Mayo. One of these parathyroids was found by Rogers. I sent him seventeen goitres with which to carry on his experiments with a serum to be used for the treatment of this disease, and although I examined the glands carefully, I overlooked the parathyroid in one. In two other cases we found the parathyroids ourselves in examining the specimens very carefully. These glands are wonderfully small. They look like a part of the thyroid tissue. They are often not larger than a small pea. The lower one is a trifle larger, but seldom larger than a small pea in this disease. The point has been brought out in recent English literature that exophthalmic goitre leads to fatty degeneration of the parathyroid. I do not think so. To make sure of not removing parathyroids all loose or separated particles on the posterior surface of the gland are left.

Dr. Joseph C. Bloodgood, of Baltimore.

One word in regard to the parathyroids. At operation and even after the removal of the thyroid enlargement it is very difficult to recognize these minute glands. In the capsule of the removed lobe of the thyroid it is not infrequent to find little shot-like nodules of reddish-brown tissue. Studied microscopically, these nodules have proved to be pieces of muscle, lymphatic-gland tissue, or normal thyroid tissue of aberrant origin, as well as parathyroids.

When the surgeon removes an entire lobe of the thyroid gland for any disease he should be on the lookout especially near the thyroid vessels for small nodules resembling the parathyroid, and he should attempt not to remove these, but to brush them back into the wound with a piece of gauze, and in the dissection to keep as close to the capsule of the thyroid as possible.

Experience has demonstrated that no symptoms follow the complete removal of one lobe of the thyroid gland with its parathyroids. The importance, however, of using every possible precaution not to remove these parathyroid glands is due to the fact that many lesions of the thyroid are bilateral, and second operations on the remaining portion of the gland may become necessary, and now, if the parathyroids are removed or injured, fatal tetany will take place.

One can be certain of the presence or absence of the parathyroids in the specimen removed only by a microscopic examination of all pieces of tissue adherent to the capsule resembling the parathyroid.

Dr. Arthur Dean Bevan, of Chicago.

I would like to say a word or two in regard to thyroidectomy in cases of exophthalmic goitre. In the locality in which I am doing surgical work exophthalmic goitre furnishes us our important cases, and the operation of thyroidectomy is important from the standpoint of applying it to these cases. I have been much impressed with the great benefit derived by operation on exophthalmic goitre cases. I have operated on sixteen cases of exophthalmic goitre with one death. The relationship between the removal of the goitre tissue and the clearing up of the symptoms has been so definite that I believe we should urge operations for exophthalmic goitre cases very much more strongly than we have in the past, unless the future should show that serum-therapy will make the operation unnecessary.

I have had, for instance, a woman who had lost sixty pounds in weight in sixty days. From one hundred and sixty pounds she declined in weight to ninety-eight and one-half pounds with exophthalmic goitre. She was dying rapidly. I removed the larger half of the gland and ligated the vessels upon the other side, the operation being followed immediately by an improvement which was very rapid. Within two months forty pounds of her lost weight was regained; and in my sixteen cases, exclusive of the death mentioned, improvement has been so constant, with the exception of two cases, that I have no doubt but what we have in the thyroid a cause of the condition, and that we can cure the condition better at present by operating on these thyroids than by any other method.

Just a word or two in regard to pure exophthalmic goitre and simple struma. We have noted not infrequently exophthalmic goitre following simple struma, and I must say, that there is such a condition. As an example, a woman, aged sixty years, with a goitre lasting for eighteen years, developed within a few months very marked exophthalmic symptoms. I operated on the goitre, removing about one-half of the gland, and ligating the vessels upon the other side. For a week the

patient was *in extremis* almost, with a heart action varying from 140 to 160, such as we see in these cases, and yet histological examination of that goitre tissue showed absolutely the same tissue we find in simple struma. The histological examinations of my cases have been made by Dr. Dean Lewis and reported in the *Transactions of the Chicago Pathological Society*. These show that although we have a typical picture in the ordinary exophthalmic goitre case histologically, on the other hand there is a certain class of cases in which we have the same clinical picture, yet histologically the findings of simple struma.

Dr. Shepherd. I did not intend my paper to be one on exophthalmic goitre, but it was simple thyroid I was talking about.

As to what is exophthalmic goitre and what is not, is a debatable question We do not know exactly where to draw the line accurately.

With regard to general anesthesia, I can only relate my own experience. I am sorry that so many patients have died in the vicinity of Albany from anesthesia, and I must say that there must be something wrong with the anesthetic. I have not had any fatal results from this source.

I have examined a number of these cases with a view to finding the parathyroids; our pathologist at the Montreal General Hospital has examined them also, and, as Dr. Bloodgood has said, they are not easy to find. When they have been found, in exophthalmic goitre, they have not been found degenerated, but perfectly normal.

A REVIEW OF 1500 OPERATIONS UPON THE GALL-BLADDER AND BILE PASSAGES, WITH ESPECIAL REFERENCE TO THE MORTALITY.

By WILLIAM J. MAYO, M.D.,
ROCHESTER, MINN.

Between June 24, 1891, and May 1, 1906, Dr. Charles H. Mayo and myself have performed 1500 operations upon the gall-bladder and bile passages, of which number 96 per cent. were operated upon in St. Mary's Hospital, Rochester, Minnesota, and under nearly identical conditions. 1000 of these cases were commented upon in a paper read before the Southern Surgical and Gynecological Association, December, 1904, and will be found in the *Transactions* of the society for that year.

The three most important considerations in the surgical treatment of any disease are (1) the mortality, (2) the permanence of cure, (3) the disability arising from the operation itself. The following investigation has been conducted with a view of elucidating the truth in regard to these essentials.

Mortality. The first question to be considered concerns the operative mortality. In the 1500 operations there were 66 deaths, 4.4 per cent. In the first 1000 cases previously referred to, the death rate was 5 per cent.; in the last 500 since that time 3.2 per cent. This includes acute perforations with spetic peritonitis and malignant disease. These statistics give, as an operative death, every case dying in the hospital without regard to the length of time thereafter. It includes deaths from accidental causes, such as pulmonary embolus, myocarditis, and a number of cases dying from chronic conditions occurring after one month,

one from chronic nephritis as long as ten weeks after operation. This works an injustice to the statistics but eliminates the personal equation.

There were 845 cholecystostomies with a mortality of 2.13 per cent. In the last series of 500 there were 272 cholecystostomies with a mortality of 1.47 per cent. Two of these were sudden deaths from pulmonary embolism.

Looked at from the standpoint of mortality, cholecystostomy is the safest for the average case and must be considered the normal operation. As we had but one case of our own in the entire series of 1500 operations in which gallstones reformed in the gall-bladder, this cannot be taken as a valid objection to leaving it *in situ*.

There are some conditions in which after cholecystostomy, future trouble may be expected. First, in all those cases in which the cystic duct is obstructed by a stone and the gall-bladder takes no part in the biliary circulation (contains no bile), other things being equal, it should be removed, as in this condition we have occasionally had to remove it secondarily for the relief of mucous fistula or colics due to obstructions to drainage from kinking or stricture. Second, thick-walled gall-bladders which have become functionless, lead to a suspicion of malignant disease and should be excised. We have in this way several times unexpectedly removed what proved to be an early carcinoma of the gall-bladder. One such patient is now alive more than three years.

In connection with common duct surgery it is not wise to remove a functionating gall-bladder unless for direct indication. This is particularly true if cholangitis exists, as common duct cases more often require a secondary operation than any other and the gall-bladder not only affords easy drainage and enables cholecystenterostomy should there be future contraction and obstruction of the common duct, but it is also a safe guide to the deep ducts if future trouble should arise.

As to permanency of cure our cholecystostomies have remained well with the exception of a few instances of bad selection in our

early experience in which cholecystectomy would have been the better operation.

The operative disability after cholecystostomy was brief. A short incision with separation of the fibres of the rectus muscle rendered early union without hernia almost a certainty. By turning in the cut margins of the gall-bladder about the tube (Summers) in a similar manner to the Stamm-Kader gastrostomy, the bile discharge stopped promptly as, on removal of the tube at the end of the week, the peritoneal surfaces agglutinated. The average patient was up in twelve days and left the hospital within two weeks.

CHOLECYSTECTOMY.

There was a total of 319 cholecystectomies with a mortality of 3.13 per cent. In the cholecystectomies in the last series of 500 cases the mortality was 1.62 per cent.

Cholecystectomy has an increasing field of usefulness, but its increase of mortality, which, although slight, is for one reason or another fairly certain, prevents it from replacing cholecystostomy. At the same time, when the circumstances permit of easy removal of the gall-bladder and the disease is confined entirely to this organ, it is the operation we most commonly perform even in cases in which cholecystostomy would answer the purpose. But if the patient is very obese and the gall-bladder has a broad attachment to the liver necessitating prolongation of the incision or increased manipulation, cholecystectomy is the more difficult and dangerous operation.

The permanence of cure after cholecystectomy is of course absolute when the disease is confined to the gall-bladder. In the majority of cases the incision was made nearly if not quite as short as for cholecystostomy. The period of convalescence was therefore about the same. In a few cases a longer incision was required, adding several days to the disability. It was very rarely that a patient was in the hospital more than fourteen days.

OPERATIONS UPON THE COMMON DUCT.

207 cases. Operations upon the common duct so far as the mortality is concerned can be divided into four groups. This arrangement is more or less artificial as some cases are hard to classify.

Group 1. 105 cases with three deaths, 2.9 per cent., consisting of those patients in whom gallstones were present in the common duct but without immediately active symptoms. Jaundice was moderate or not present. If it was present the obstruction was incomplete or intermittent and permitted of the escape of a certain amount of bile into the intestine. There was comparatively little infection of the ducts and, with the exception of the presence of mucus, the bile was normal. The operation under such circumstances was simple and the convalescence short, the patients usually being able to leave the hospital within fifteen days, and the cure has been permanent.

Group 2. 61 cases with ten deaths, 16 per cent. A series of cases in which there was active infection not only in the common duct but also involving the ducts of the liver. Stones were usually present. The patient not only had jaundice but suffered from Charcot's fever (malarial type, irregular chills, followed by a temperature from 103° to 107° passing off in a few hours with sweating); pain intermittent and most marked just previous to the active symptoms; during the remissions a little bile passed the obstruction relieving the liver. Among the older writers this was called "remittent bilious fever." The added infection at once introduced an element of grave danger, not only from the operation itself but also through the production of certain complications which caused death in the first two months.

The patient also had an increased possibility of future trouble as it was in this group that hepatic duct stones were formed, of which we have seen seven examples. The infection and interference with drainage from a stone formed in the gall-bladder but which had passed into and lodged in the common duct furnished the necessary conditions for their formation. The cholangitis may

subside and the stones reach a more or less quiescent state, but after removing the calculi from the common duct others which have formed in the hepatic ducts may pass into the common duct causing future trouble.

Coincident enlargements in the head of the pancreas or changes in the duct wall may lead to secondary stone formation. Under such circumstances we have four times seen stones reform in the common duct after periods of from one to five years, requiring second operations. In two the gall-bladder had been removed at the primary operation and the stones were too large to have come down from the hepatic ducts. The possibility that these stones had as their nuclei hepatic duct calculi cannot be denied in one case but it does not seem possible that this was the fact in the other three. It was this group that was so often found associated with inflammatory diseases of the pancreas.

As a rule these patients were in the hospital from three to four weeks.

Group 3. Complete obstruction of the common duct. 29 cases with ten deaths, 34 per cent. It is hardly necessary to call attention to the fact that formation of bile is only one of the functions of the liver and that a patient may live for a great length of time with nearly if not quite complete obstruction of the common duct, the necessary amount of bile being absorbed by the blood and eliminated with the urine, perspiration, etc. In Group 1 we found the bile comparatively healthy, containing only a moderate amount of mucus. In Group 2 the bile was darker, containing a large amount of mucus and often showing colon bacillus on culture. Group 3 showed almost no bile in the ducts and the little present was thin and of a dark spinach green color, or in the worst cases a condition of complete acholia was manifest, the ducts being filled with a clear, colorless, mucoid secretion. The patient's general condition was extremely poor, pulse feeble and rapid, and in the long-standing cases there was sometimes œdema of the feet and free, bile-stained fluid in the peritoneal cavity. Albumin and casts in the urine and other evidences of extreme toxemia were usually manifested.

The operative mortality in this group during the period of complete obstruction was very high, 34 per cent., including deaths from early and late complications. Acute obstructions of this type when accompanied by evidences of infection were especially fatal, and as acute obstruction from stone is seldom permanent, it is often wise to wait for a period of remission before operation. It seldom happens that the duct will not dilate sufficiently in the early stages to permit of some relief of the symptoms, and this is the time to interfere, although later the inflammatory products in the duct wall may contract down upon the stone giving rise to permanent obstruction. In a few instances of complete obstruction which came on suddenly and which remained without temporary remission of symptoms, spontaneous cure by sloughing of the stone into the intestine took place. We have seen four examples. In each, after years of typical gallstone symptoms, there was sudden and complete obstructive jaundice. In two there was a steady temperature, and in all four there was a peculiar rigidity of the upper abdomen. After from six to twelve weeks of acute and severe symptoms the patient suddenly became relieved, the jaundice disappeared and a large gallstone was found in the stool. Three of these patients were subjected to operation subsequently. In all, one or more stones were found in the gall-bladder or in the adjacent liver border, the centre of a cicatricial mass but without communication with the bile tract, the common duct being densely adherent to the duodenum at the site of perforation.

The most common causes of death after operation in this group have been exhaustion from cholemia with or without capillary hemorrhage and from sudden cessation of liver function. All of the patients who recovered remained well. The hospital disability averaged a little over three weeks.

Group 4. This group concerns malignant disease. Twelve cases. Four deaths, 33.3 per cent. mortality. Cancer of or involving the common duct occurs in two forms. First, the primary tumor of the common duct or papillæ, a small, hard, grayish-white mass with a tendency to remain localized until a late stage. We have seen several examples and have had two primarily successful

excisions but no case which has lived beyond three years. Second, common duct obstructions from carcinoma extending downward from the gall-bladder and cystic duct, or from cancer of the head of the pancreas. These cases are of course inoperable and even an exploration proved fatal in several instances.

RELATION TO PANCREATITIS.

One of the most interesting problems in connection with surgery of the bile tract concerns coincident inflammations of the pancreas. In a total of 86 out of the 1500 cases the pancreas was involved to such an extent as to be noticeable on examination. Four of these cases were acute, of which two recovered and two died. Six were subacute, two of these having hemorrhagic cysts; five recovered and one died; nine cancers and five deaths. Sixty-seven had chronic pancreatitis; the evidences usually consisted of hard nodules most marked in the head of the pancreas and near to the common duct. Four of these cases, supposed to be common duct obstruction from chronic pancreatitis alone, were shown by subsequent operation to have had an undiscovered stone in the ampulla. In a few cases the pancreatic disease apparently was not secondary to the bile tract.

That the acute forms have had a deleterious effect upon the patient is unquestioned, but I have been unable to separate the harm done by the chronic inflammations from the essential condition in the bile tract and I do not believe that unless it was obstructive it had a decided influence on the prognosis.

In summing up the causes of the sixty-six deaths, 10 or 15 per cent. were accidental and could be eliminated. The largest number were due to cessation of liver function, usually the result of infections, microscopical examination showing destruction of the epithelial elements of the liver and often fatty degeneration. Next came exhaustion from blood changes due to chronic cholemia.

It was the mortality and complications of delay that placed the early operation for appendicitis on a sound surgical footing. To remove the disease while still in the appendix and before its

rupture involved the abdominal cavity, was the logical conclusion.

The same reasons apply and with equal force to the early operation for gallstone disease. Remove the disease while still in the gall-bladder by a mortality of from 1.47 per cent. (cholecystostomy) to 1.62 per cent. (cholecystectomy). This includes death from accidental causes, acute perforation and gross infections. Excluding these cases a mortality of less than 1 per cent. can be shown.

With the passage of the stone into the common duct we no longer have a localized disease but one fraught with grave dangers from liver infection and cholemia, and in this condition nearly one in seven of our cases came to operation while one in twenty-five developed malignant disease of the gall-bladder or bile tract and in most of these cases gallstones were present. In other words, one patient in six had allowed the favorable time to go by, although in the very large majority symptoms had long given warning as to the nature of the disease.

THE SERUM THERAPY OF TETANUS.

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In order to avoid discussion of the scientific side of my subject which will be presented with so much greater authority by Dr. Pease, and a repetition of the statistics assigned to Dr. Jacobson, to whom I have sent the Boston cases of tetanus, I shall limit my paper to a brief discussion of the use of serum in cases in which tetanus has developed where no prophylactic injections have been made. In order to make intelligible, however, the indications which any method of treatment must attempt to fulfil, I will very briefly summarize the most recent conclusions as to the manner in which the tetanus toxins spread through the body of the infected individual.

Our present knowledge of tetanotoxin, obtained by countless experiments upon the lower animals, is certainly one of the most striking examples of the wonderful results of modern scientific methods. Though a few links are missing in the chain of evidence enough is known, I think, and proved true beyond reasonable doubt, to justify the statement that a logical treatment of tetanus by serum is at least in sight. We can also, in part, explain the hitherto baffling discrepancy between the highly satisfactory use of the serum in laboratory experiments, where results can be foretold with almost mathematical accuracy, and our frequent disappointments at the bedside. In a recent and most excellent paper by Dr. N. Tiberti, of Florence, published in the *Centralblatt f. Bacteriologie*, 1905, the succeeding steps of the discoveries of the dissemination of tetanotoxin throughout the body have

been described. Of the names associated with the subject of tetanus—Kitasato, Behring, Brunner, Gumprecht, Goldscheider, Kartulis, Nicolaier, Oppenheimer, Vallard and Vincent, Wassermann, etc.—most credit, perhaps, for work upon the manner of the transference of tetanus toxins through the body should be given to Marie and Morax, and to Meyer and Ransom.

Briefly put, our present knowledge is as follows: Tetanus toxin, by diffusion from the local lesion, (1) enters the motor nerve plates of the adjacent muscles, passing thence *within* the axis cylinders of these motor nerves upward to the motor ganglia in the cord; (2) by lymphatic absorption it enters the general blood current, where it remains until it is excreted or destroyed, or is carried to all the muscles of the body, to be absorbed through their motor plates. This centripetal passage of the poison occurs in response to a very powerful affinity between the toxins and the higher central ganglia, which is not satisfied until a stable union of cell and poison has been formed, often only to be dissolved by death. This fact, that tetanospasmine, wherever and however introduced into the circulation, always makes for the central motor ganglia, combined with the probability that *tetanus antitoxin, unless directly introduced into nerve tissues* (whether given subcutaneously or intravenously), *never reaches these ganglia at all*, or else in insufficient amount to be of value, gives us our most important concepts for a rational treatment of the disease. Of almost equal importance with these is a thorough recognition of the fact that antitoxin ascends the axis cylinder more slowly than the toxin, and that, in order to be efficacious, it must be introduced at a higher level than the toxin and before a stable union of nerve and poison has occurred. Though further knowledge may necessitate some modifications in these statements, there is ample evidence to justify our treatment, for the present, along these lines.

Our indications for treatment, then, are these: (1) To anticipate the centripetal course of the toxin by an immunizing injection at a higher level. (2) By local injections of antitoxin, to neutralize the toxin at its upper limit of advance. (3) By intravenous

or subcutaneous injections, to neutralize all circulating toxins. (4) To prevent or retard, so far as possible, lymphatic absorption from the focus, and by local parenchymatous injections, to render the poison inert. (5) By amputation or excision, with germicides, etc., to remove the source of infection when it is possible. (6) By symptomatic treatment or the newer anesthetic treatment, cocaine, etc., or magnesium sulphate, to aid the specific serum.

1. If further investigation prove the truth of our present view, that antitoxin, unless injected directly into nerve tissue, never reaches it, the uselessness of cerebrospinal lymph-sac injections becomes obvious. As lumbar puncture has become in the last few years almost a routine treatment in bad cases of tetanus, and as anesthesia is often required, it is of very great importance to discover the truth about this question, for if subarachnoid antitoxin is no more valuable than subcutaneous injection, it should certainly be abandoned. Scratching the nerves of the corda equina in order that the serum may thus have a point of entrance seems to me too uncertain to warrant its attempt.

Direct injection into the cord was first practised and advocated, so far as I am aware, in a very important paper by John Rogers, of New York, published in the *Journal of the American Medical Association*, July 1, 1905. He made several injections, and, so far as he could see, did no harm. These were made in one case between the sixth and seventh cervical vertebræ, in another between the second and third dorsal. He believed that temporary benefit undoubtedly followed this heroic treatment, which, owing to its manifest possibilities of danger, should certainly be reserved for desperate cases. Injections into the low lumbar cord would be less dangerous, and may be used in the graver cases, which do not respond to more peripheral toxin blocking.

Though I can find no mention in literature, and have never put the idea into execution, I would like to suggest the possible value of antitoxin injections into the higher peripheral motor nerves which would obviously be less dangerous than injections into the cord. The antitoxin would thus be carried to the motor tract at the highest possible level. I recommend a trial of injections

into both hypoglossal nerves, perhaps also into the spinal accessory, which treatment should be repeated at short intervals. With the same object in view, would it not be possible that intraneural injections into the brachial plexus might be of use to check toxins ascending from the lower limbs or reaching the motor ganglia from the body muscles?

2. As toxin is always found in the motor nerves of the affected part, there can be little question that intraneural injections, as near as possible to the cord, are clearly indicated, and with either general or local anesthesia are not very dangerous. We must always bear in mind that toxin travels faster than antitoxin, and that injections at a low level are very much inferior to those made at a high level. The nerves of the brachial plexus or those in the axilla, or the anterior crural, sciatic, and obdurator, should be isolated and filled with antitoxin to twice or three times their normal size at several points. Care should be taken to inject directly into the nerve and not into the perineurium. The question of the repetition of these injections will depend chiefly upon whether the original source of supply of toxin has been removed or not, and upon their control of symptoms. After two or three injections into the nerves, in cases in which the original source has been destroyed, it is an error, I think, to continue subcutaneous or intravenous injections of antitoxin; for they are useless and harmful, the symptoms, if they persist, being due to toxin already in the cord beyond the reach of antitoxin injected other than into the cord itself. Temporary loops of gauze tape placed about the nerves greatly facilitate their withdrawal from the wounds for subsequent injections.

As we know with the greatest certainty that the integrity of the axis cylinders is essential for the centripetal passage of the tetanotoxin from the limb, it follows that whatever will break this continuity will absolutely block further absorption from the member supplied by the nerve. I would suggest the advisability, in certain cases, of *nerve section*, in place of amputation, with the hope that a secondary suture might be successful if recovery ensued.

3. While immediate use of intravenous and subcutaneous

antitoxin injections is all-important at the outset, and while these injections should always be continued so long as there is any possibility of a continuous absorption from the wound, the limitations of such treatment from a theoretical standpoint are equally obvious and are confirmed by clinical experience.

4. As a considerable amount of the poison is transported through the lymphatic system, it follows that any check to such absorption would be beneficial; for example, as most of the lymph from the extremities is returned to the body by lymph vessels *superficial* to the *deep fascia*, Bier's passive hyperemia treatment would certainly diminish toxin absorption. If, instead, the limb were circumcised down to the deep fascia and the peripheral tissues were soaked with antitoxin, given both subcutaneously and into the muscles, it would seem that no more toxin could reach the general circulation. If the limitations of antitoxin given subcutaneously or intravenously are realized, and patients with acute tetanus are treated along the lines which I have just outlined, we would expect a distinct improvement in the symptoms or in the mortality over the older cases. Though the clinical experience with intraneural or intraspinal injections is limited, so far as I am aware, to eighteen or more cases, it is the opinion of the surgeons who have reported them that this expected improvement in the results has been demonstrated.

In closing, I should like again to emphasize my conclusions as to a rational use of serum in acute or severe subacute tetanus. While some of the details upon which it has been founded may subsequently require change, such a consistent method of attacking the tetanus toxins, resting, in the main, upon well-founded experiments, has the merit of simplicity. In carrying out this treatment we should picture to ourselves the toxins travelling the motor nerves of the affected part, ever upward toward the highest motor ganglia and also by absorption through the lymphatics, entering the general blood current, to be brought *indirectly* to the central ganglia through the motor nerve endings of the rest of the skeletal muscles. Antitoxin, to be effective, must reach the poison before it has entered the motor tract, or must

by direct injection into nerve tissues, immunize them in anticipation of the arrival of the after-coming toxin.

Treatment. 1. Immediate intravenous and subcutaneous injections to neutralize circulating toxin.

2. Immunizing or neutralizing injections at the highest level which the severity of the symptoms appears to justify; directly into the cord, as advocated by Rogers, or into the higher motor nerves, such as the hypoglossal and spinal accessory, as suggested by myself.

3. Peripheral intraneural injections as near to the cord as possible. Where amputation is not indicated or allowed, there is positive experimental evidence that nerve section will isolate the toxins in the limb.

4. Lymphatic absorption will be diminished by the application of Bier's principle of passive hyperemia or by circumcision of the limb.

5. Parenchymatous injections, *especially into the muscles*, may be found of distinct value in addition to subcutaneous and intravenous injections.

6. If possible, the local focus should be thoroughly eradicated.

7. We have no right to neglect symptomatic treatment.

8. Animal experimentation gives us no ground for hoping that any treatment whatever can be successful, when once the disease has progressed beyond a certain stage.

THE SERUM THERAPY OF TETANUS.

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As the title of this paper indicates, its scope is restricted to a consideration of the therapeutic value of the antitoxin treatment of tetanus. However, it is essential in order to obtain a just estimate of the value of the antitoxic serum that we appreciate certain principles which laboratory investigation seems to have firmly established, and that we study carefully our clinical experiences.

The Tetanus Bacillus. Tetanus is essentially a dirt disease. Its etiological agent, the tetanus bacillus, commonly inhabits the surface dirt, and yet it belongs to the class of bacteria incapable of developing in the presence of atmospheric oxygen.

It has been definitely shown by Debrand[1] and others, however, that oxygen-consuming bacteria, by using up the available oxygen in their development, create the proper anaërobic conditions necessary for the growth of the tetanus bacillus. This symbiotic growth of aërobic and anaërobic bacteria is an exceedingly common phenomenon in nature.

The tetanus bacillus and its spores have a most tenacious vitality and can live under natural conditions entirely unfavorable for the existence of most pathogenic bacteria. Living spores can exist in dust and other dry dirt.

[1] Annales de l'Institut Pasteur, 1902, 16, 427

The bacillus thrives best at the body temperature, and can develop but little, if at all, below 60° F. On this account it may be assumed that the organism is more active during the summer months. One of us has shown[1] that the large majority of cases of tetanus in New York State occur from May to October, with June, July, and August as the months of maximum activity.

That it is a frequent habitant of the intestinal tract of animals, especially horses and cattle, has been amply shown by numerous workers, but more recently by Hoffman.[2] This fact is important as all wounds received in stables or contaminated with animal discharges are particularly to be feared. Pizzini[3] has also found it in the feces of man. Tavel[4] and Libman[5] describe an anaërobic spore-forming tetanus-like bacillus in the human appendix.

In this connection reference should be made to the clinical evidences of the source of infection in man being sometimes in the intestinal tract.

In Table I accompanying this paper are five cases following operations performed under aseptic conditions upon the intestines and reported by Brewer (Table I *a*30), Goodrich (Table I *a*44), Willy Meyer (Table I *b*19) Kammerer (Table I *b*20) and Roe (Table I *b*45). Four of them were for the removal of the appendix in the quiescent period, and followed the operation twice in nine and once in ten and eleven days, respectively, while in the fifth colectomy was performed for the removal of a cancer of the splenic flexure.

Rather more difficult of explanation is the portal of entrance of the bacillus in a case reported by Warbasse (Table I *a*36), in which tetanus appeared six days after the performance of supra-vaginal hysterectomy and double oöphorectomy through an abdominal incision.

That tetanus can readily follow unclean surgical procedure

[1] Pease, Medical Review of Reviews, 1904, x, 524.
[2] Hygienische Rundschau, 1905, xv, 1233.
[3] Quoted by Hoffman.
[4] Centralblatt f. Bakteriologie, Erst. Abt., 1898, xxiii, 538.
[5] Quoted by Buerger, American Journal Medical Sciences, 1905, Series, cxxx, 267.

appears in a case reported by Mudd (Table I *c*12), in which it was the sequel of an open operation for varicocele performed by a doctor connected with an advertising institution and admitted into St. Luke's Hospital, St. Louis, after the disease had become established.

In a series of three cases reported by Fourneau[1] as having occurred at the Göettingen clinic one followed a Bassini operation the radical cure of hernia. This infection was attributed to a case of tetanus cared for on the preceding day. No case of tetanus having occurred in this klinik for seven years, the reporter states that they were thrown off their guard and proper precautions to avoid infection had not been taken.

The danger of the transmission of the disease in hospitals is not generally appreciated. In this country, as far as we are informed, the only hospital in which complete isolation from all other surgical patients is practised is the Pennsylvania, in Philadelphia, where all tetanus cases are transferred to the medical service for treatment.

Conditions of Infection. The occurrence of idiopathic tetanus is most likely. It is essential for the production of the disease that the bacillus either in its vegetative or spore state, or its toxin, must gain entrance into the tissues of the body through some injury to the skin or mucous membrane. The disease is a true intoxication, and the tetanus toxin alone is capable of producing it. Yet tetanus toxin fed to animals is not absorbed as such through the uninjured digestive tract, but is either digested or passed out with the feces unchanged.

Once having gained entrance into the tissues, the bacillus is capable of producing its toxin only under certain conditions.

Some years ago Villard[2] and more recently Tarozzi[3] showed that the spores of the tetanus bacillus when freed from the toxin before injection into the body did not produce the disease unless other substances were also injected, or conditions created which would bring about necrosis in the tissues.

[1] Deutsche medizinische Wochenschrift, 1904, 10.

[2] Annales de l'Institut Pasteur, 1892, 6.

[3] Centralblatt f. Bakteriologie Erst. Abt., 1906, xl, original, 305.

While necrosis is essential for infection, neither the incubation, the onset, nor the severity of the attack is strictly dependent upon the amount of visible destruction of tissue or suppuration which takes place. The explanation of this is that minute quantities of tetanus toxin have the most powerful poisonous effect, and but very slight development of the bacillus is required for the production of several fatal doses of the poison. Thus Vincent[1] has recently shown that the subcutaneous injection of small amounts of solutions of quinine and its salts, which contained tetanus spores deprived of their toxin, brought on fatal attacks of tetanus. In these cases the determining factor appeared to be the slight necrosis induced by the quinine injected. He states that tetanus is a frequent sequel to subcutaneous quinine injection, but a rare development after the subcutaneous administration of morphine. The latter drug he states does not produce necrosis.

Another active factor in the determination of tetanus infection is the presence of aërobic bacteria in the injured area, and the symbiotic development of them and the tetanus bacilli. Thus von Hibler[2] has shown that mildly virulent tetanus bacilli can be enhanced in pathogenic power by coincident mixed infections; Garnier,[3] that the injection of typhoid cultures together with tetanus toxin increased the toxic power of the latter, and Zanfroguini,[4] that the presence of the colon bacillus and the staphylococcus aureus had the same effect.

Distribution of the Tetanus Bacillus in the Body. Ordinarily the tetanus bacillus is present in the body only at the site of injury. It has been shown, according to authors quoted by Tarozzi,[5] in a few cases of tetanus in man, that the bacillus was found at autopsy in the sciatic nerve, the spinal cord, the medulla oblongata, lymph nodes, cerebrospinal fluid, and spleen, and during life in the circulating blood. Tarozzi by experiment showed that

[1] Annales de l'Institut Pasteur, 1904, xviii, 748.
[2] Centralblatt f. Bakteriologie, Erst. Abt. Ref., xxxvii, 545.
[3] Archiv. de Med. Experiment., 1904, 16, 557.
[4] Centralblatt f. Bakteriologie, Erst. Abt. Ref., 1906, xxxvii, 650.
[5] Loc. cit.

spores injected into animals were found in a live state in the internal organs, especially in the liver, as late as three months afterward.

Vincent[1] found that if animals which had been injected with solutions containing spores freed from toxin and kept in incubators at high temperatures, that the bacteria were most likely to wander into the circulating blood and would develop, and tetanic symptoms would be produced.

Of the sources of infection not yet mentioned is the injection of solutions containing gelatin for the purpose of controlling hemorrhage. Two such cases are reported[2] as having occurred at the clinic of Helferich in Kiel. In the first instance it was given subcutaneously into the thigh two hours before the performance of laryngectomy to prevent uncontrollable capillary hemorrhage. This it accomplished. But tetanus appeared six days after, with evident septic disturbance in the thigh. The muscles of the back and lower extremities were particularly convulsed. Death followed promptly, despite the use of the antitetanic serum. The field of operation in the neck showed no evidence of infection.

In the second case it was used to control secondary hemorrhage occurring from a subphrenic abscess. After a period of six days severe tetanus appeared, which was fatal in two days.

Period of Incubation. All the factors mentioned, as determining the occurrence of tetanus, exercise a proportionate influence upon the period of incubation, the character of the onset, the course, and the termination of the disease.

The period of incubation may vary within wide limits. Rose and many others have reported incubation periods as short as twenty-four hours and even less. If what is now quite generally accepted as the path of the poison from the site of its production to the nerve centres is correct, then such cases as have been recorded with periods of incubation under three days must be accepted with considerable reserve.

[1] Annales de l'Institut Pasteur, 1904, xviii, 450.

[2] Deutsche Zeitschrift f. Chirurgie, October, 1901.

And yet a case reported by Kuhn,[1] of Cassel, at the Versammlung Deutscher Naturforscher und Aerzte offers a new explanation of this group of cases. A boy, a bleeder, had been operated upon for the removal of adenoids from his nasopharynx. The hemorrhage being uncontrollable, a gelatin injection was given him. At the site of injection gangrene promptly appeared and after twelve hours general tetanus was present, from which death speedily resulted. Schuckmann[2] commenting on this case expresses the opinion that the gelatin injection must have contained a poisonous dose of toxin, the injection of which, rather than the bacillus, caused the death.

While a short incubation period usually implies intensity of infection, Warbasse (Table I *a*38) reports the case of a patient aged thirteen years, resulting from a punctured wound of the foot, from the penetration of a nail, with an incubation period of but four days. The treatment consisted in the injection of 20 c.c. of antitoxin subcutaneously. The case was one of general tetanus, yet terminated in recovery.

On the other hand in Table I appear seven cases in which the disease did not manifest itself until the nineteenth day in one, the twenty-first day in three, the twenty-fifth day in two, and the twenty-sixth day in one. Four of these were treated with subcutaneous injection of the serum, two by intraspinal and one by deep intramuscular injection. All of the cases recovered except the last one. This patient, twenty-five days before, had received a punctured wound of the sole of his foot and entered Johns Hopkins Hospital on the first day of the disease. For a few days he seemed to improve under the serum treatment, and it was discontinued. Death occurred suddenly on the seventh day. This case must be considered as one in which the appearance of tetanus was delayed, but yet in which the infection was virulent when awakened into activity.

In Table II occur three cases with incubation periods of eighteen, nineteen, and twenty-two days respectively. One of them was

[1] Berliner klinische Wochensch., 1901, p. 1118.
[2] Deutsche med. Wochensch., March 5, 1903.

so mild that recovery would have occurred under any treatment, and in another, the result of a burn, the general condition is stated to have been exceedingly bad and is held responsible for the death. The third recovered, having received 800 c.c. of antitoxic serum in the course of eight days.

It is interesting to note that in only one of these ten cases was a punctured wound responsible for the tetanus, most of them having been due to crushed or lacerated wounds.

The analysis of our tables furnishes some very suggestive facts upon this point. In them will be found 52 cases due to blank cartridge or gunshot wounds presenting an average incubation period of 7.3 days with a mortality of 76 per cent. and 51 punctured wounds with an average incubation period of 7.9 days, a mortality of 74.5 per cent., while in the 28 lacerated wounds tabulated, the incubation period was 11.8 days and the mortality 53.6 per cent.

We must now consider what occurs during the period which intervenes between the receipt of the injury and the appearance of the first tetanic manifestations.

The Relation of Toxin to the Nervous System. New light has been shed upon the pathology of tetanus by the researches of Meyer and Ransom[1] and Marie and Morax.[2] Their work has been viewed so frequently that it is only necessary at this time to recall the main conclusions that have been reached.

The presence of tetanus toxin in the living body causes no symptoms, clinically appreciable, until it has been absorbed by the muscular terminations of the motor nerves, has passed along their axis-cylinders, and has reached the motor root cells in the spinal cord. While the toxin is in the nerves or in the spinal cord acting upon the spinal cells, it is effectually isolated from antitoxic substances present in the blood or lymph circulations If, however, a nerve or the spinal cord be injured in such a manner as to expose the axis-cylinders or the nerve cells to the toxin in the blood or lymph, the affinity of the toxin for such nerve

[1] Archiv. f. experimentelle Pathologie und Pharmakologie, 1903, 49, Heft 6

[2] Annales de l'Institut Pasteur, 1902, xvi, No. 11, and 1903, xvii, No. 5.

element is soon manifested by awakening a tetanic condition in the part controlled by that nerve or the affected nerve cells. Odier[1] claims that the toxin has a lytic effect on the outrunners of the motor end-plates, and that it has a somewhat similar effect upon the axis-cylinders of the nerves, proportional to the amount and concentration of the toxin passing through them. In other words, it is apparently possible for the toxin to come in contact with the nerve elements for which it has a strong affinity at only one point, namely, at the termination of the motor nerves in the muscles. The time taken for the toxin to be absorbed and to pass through the nerves represents the large part of the period of incubation. Courmont and Doyan[2] have shown that the period of incubation in different animals is roughly proportionate to the distance between the termination of a nerve and its central nerve cell. The early appearance of trismus, in natural infections, can be explained by the fact that the nerve supplying the muscles of mastication is a comparatively short one. Thus, the period of incubation is the net result of the length of nerve and the degree of concentration of toxin at the point of its absorption by the nerve terminals.

It is apparently established that the toxin produced at the portal of entry of the tetanus bacillus is absorbed by the muscular terminations of the motor nerves of the part as well as the lymphatics, is transported directly through the axis-cylinders of the nerves to the cord, and also by an indirect route through the lymphatics to the blood and thence by way of other nerve fibres to the spinal cord.

Tetanus Antitoxin. There is not the slightest question of the power of tetanus antitoxin to neutralize free tetanus toxin outside the body or in the circulating blood or lymph channels. To what extent it can release the organ-bound toxin has not yet been determined. There is no experimental or clinical evidence that it has any effect on the toxin passing along the axis-cylinders

[1] Archives de Médecine Experimentale et d'Anatomie Pathologique, 1904, 16, 451.
[2] Quoted by Marie and Morax.

of the nerves, even if it is present in large amounts in the circulating blood.

The histological arrangement of the parts prevents the toxin present in the blood and lymph from acting directly upon the sensitive nerve cells, despite its apparent propinquity. This same condition affords an effective barrier, which likewise prevents the neutralization of the toxin by the antitoxin when once the latter has passed into the axis-cylinders and has reached the nerve cells.

The absence of a standard method of expressing the antitoxic strength of tetanus antitoxin renders it impossible to properly estimate the exact amount administered in a given case and materially interferes with our reaching definite conclusions in this regard in studying the accompanying tables.

A committee has been appointed by the Society of American Bacteriologists, to whom this matter has been referred, and we shall have therefore before long a standard serum of known strength.

While in the cases reported in this paper an effort has been made to specify the names of the producers of the antitoxin used, no comparison of the relative merits of the different varieties has been attempted.

A review of our tables will indicate that in many instances what might be considered large doses have been freely administered, and aside from the occasional occurrence of urticaria or dermatitis no ill effects have been noted.

Preventive Injections. From what has been said, it is quite evident that antitoxin to be of the greatest service must be administered before the motor nerves have absorbed any toxin. The serum should, therefore, be administered as soon after the infliction of the injury as possible, and should be given to every person who has sustained an injury in which dirt, manure, or foreign substance could possibly have been carried into the wound. Injuries received by persons whose labor brings them in contact with the soil, or whose work is among domestic animals, should be regarded as suspicious and should receive the tetanus antitoxin as a part of the routine treatment.

These preventive injections should, however, be given intelligently, and the size of the injection, the site chosen, and its repetition, should be regulated by the character and location of the injury.

Injuries involving the nerve trunks should be treated with antitoxin locally as well as subcutaneously, in order to avoid the direct absorption of toxin by such injured nerves. For this purpose either liquid or dried antitoxin is suitable.

In injuries considerably contaminated by dirt the prophylactic dose given at the first dressing should be repeated on the third and fifth days, and again from the fifteenth to the twentieth day if suppuration still continues. The passive immunity conferred by a single prophylactic injection of tetanus antitoxin undoubtedly is of no longer duration than is that given by a similar injection of diphtheria antitoxin. This on the average is from three to four weeks. Yet the protection may be but for a few days. The virulence of the toxin may be maintained, although the outbreak of tetanus is deferred. As evidence of this, Sejour[1] reports a fatal case of only twenty-four hours' duration, the onset of which occurred twenty-two days after the injection of a prophylactic dose in a case of compound fracture.

Suter[2] reports a case of tetanus occurring forty-seven days after the use of one prophylactic dose. He has collected eleven other cases from literature.

We are able to add six cases to this list from reports made to us personally. They are, briefly, as follows:

Case I, aged eight years, reported by Dr. A. J. Ochsner; treated at St. Mary's Hospital, Chicago. Compound comminuted fracture of the left leg. One injection of 10 c.c. antitoxin of French make given sixteen hours after injury. No unfavorable symptoms until the twelfth day, when trismus and opisthotonos appeared, but which subsided after forty-eight hours, the patient then making an uneventful recovery.

[1] Gazette des Hopitaux, 1905, lxxviii, 606.

[2] Archiv. fur klinische Chirurgie, 1904, lxxv, 113; Reference Centralblatt f. Bakteriologie Erst. Abt. Referate, 1906, xxxvii, 675.

Case II.—Reported by Dr. Leonard Freeman, of Denver, Col., the injury being a punctured wound of the foot due to a nail; 10 c.c. were given several hours after the injury. Local irritation and a pronounced general erythema lasting several days occurred. Six days later there was mild trismus, with soreness of the shoulders and legs. Recovery.

Case III.—Occurred at the Pennsylvania Hospital, Philadelphia, in the service of Dr. James Tyson. The patient, aged forty-eight years, received a punctured wound in the palm of the right hand caused by a rusty nail. Four days later 30 c.c. of antitoxin were injected about the wound. On the eighth day there was pain and stiffness to the corresponding arm and forearm, associated with painful mastication. This disappeared in the course of three days.

Case IV.—Dr. J. H. Branan, Albany, N. Y., cared for a boy, fourteen years old, who received on July 4, 1905, a lacerated wound of the hand from the premature explosion of a cannon. Tetanus bacilli were found in a smear taken from the middle finger. He received an intramuscular injection of 10 c.c. July 7 and a like injection on July 15. Between these latter dates he suffered from stiffness of the jaws and of the neck muscles, which cleared up and the patient recovered.

Case V.—Dr. L. L. McArthur, of Chicago, contributes the fifth to this list of cases. The patient was injured in a street-car accident, having been rolled, crushed, and then dragged a distance before being rescued. A compound comminuted fracture of the skull resulted, dirt being ground into the wound. Both upper and lower extremities had open comminuted fractures. The injured parts received thorough surgical attention, and were made clean. On the first, second and third days she received 30 c.c. of Behring antitoxin. On the eleventh day, the wounds having done well, the scalp wound was drawn together by suture. Two days later there was a rise of temperature to 102°, and on the following day, the fourteenth after the receipt of the injury, there was trismus so that the jaws could be separated only three-eighths of an inch, and stiffness of the neck; 20 c.c. of antitoxic serum

were administered. The next day an injection of 30 c.c. was given. From this time on there was a disappearance of the tetanic manifestations.

CASE VI.—Dr. James Bell (Table I *b*47) reports the case of a patient, aged nine years, treated in the Royal Victoria Hospital, Montreal. He had sustained a contused and lacerated wound of the skin over the tibia and was given 5 c.c. of antitetanic serum as a prophylactic injection on the day following the injury. Although tetanus did not appear until the forty-seventh day thereafter, it was so virulent as to cause death in five days.

It is to be noted, however, in all of these cases, with the exception of the sixth, that the toxin was so modified in its intensity that the tetanic symptoms were of short duration and in each instance the patient recovered. In the latter, however, although the outbreak was delayed, the virulence of the toxin persisted.

Letters received from members of this Association indicate that it is the practice in the hospitals of New York, Chicago, Baltimore, Cincinnati, Cleveland, Boston, Montreal, Brooklyn, and Albany to use the antitoxin prophylactically and to inject it usually subcutaneously, although in Cleveland it is given into the spinal canal, in all of the cases in which it is believed that there is danger of the development of tetanus, and with the exceptions mentioned the disease has never appeared after such injection.

At the fifteenth congress of French surgeons the treatment of tetanus was most exhaustively considered.[1] The subject was presented by M. Vallas, of Lyons. Speaking of the preventive power of the injections of the antitoxic serum, he is most emphatic in his decision that it is an agent of such positive value that with its constant use tetanus would cease to exist altogether.

No one will pretend to claim that the prophylactic injections are to take the place of the efforts to be made in each instance to render the parts thoroughly clean at the primary dressing, or to remove all possible infected tissues.

In many hospitals reliance is placed upon these procedures,

[1] Association Francaise de Chirurgie, 1903.

and indeed this has been the policy in the hospital with which one of us is connected. In this hospital several hundred cases of wounds of such character as might have been followed by tetanus have been thus treated, and yet there has been no occurrence of that disease since 1899.

We have received the report of a number of cases treated at various of the large hospitals of the country, where excision of the infected area was practised when possible, and thorough cleansing and disinfection where this could not be done and where no serum has been used, yet tetanus has not occurred. This subject has also been considered by Bain[1] and Richardson.[2]

In the cases reported by the latter, however, the use of the antitoxic serum was combined with thorough surgical attention.

This combination of procedures is the one which should be pursued. The prophylactic injections should be given directly into the muscles, as this method affords more rapid absorption than when carried only into subcutaneous tissues as has been shown by Meltzer and Auer.[3] The injection of antitoxin into adipose tissue, as is frequently done, is probably a waste of effort and material.

The necessity of giving these injections early, so that they may indeed be protective, is made exceedingly clear when we realize that if the necessary time elapses after the introduction of the bacilli for the development of a sufficient amount of toxin, not even amputation will prevent the appearance of tetanus.

Two cases in Table I illustrate this point. In the first (Table I *b*23) a man sustained a compound fracture of the leg April 24, 1902, because of which the leg was amputated at the New York Hospital April 30th. Despite this, tetanus appeared May 3, and death occurred the next day.

In the second (Table I *a*52) a man run over by an electric car December 26, 1905, was brought three and one-half hours later

[1] Annals of Surgery, 1903, vol. xxxvii, 399.
[2] Boston Medical and Surgical Journal, 1905, vol. clii, 493.
[3] Journal of Experimental Medicine, 1905, 7, 59.

into the Massachusetts General Hospital. The wound became septic, and amputation was performed December 30th. The next day the temperature rose to 105°, the neck became rigid and dysphagia appeared. Despite antitoxin, then given subcutaneously, he died January 3, 1906.

Local Tetanus. Before considering the therapeutic use of tetanus antitoxin, there remain some points to be emphasized which have a bearing thereon.

Tetanus provoked in animals as a result of experimentation exhibits almost without exception as its earliest manifestations those of a purely local character and which are at first restricted to the neighborhood of the inoculation. This is now understood to be due to the absorption of the toxin by the motor nerve of the part. The conditions favoring the local appearance of tetanus are a short motor nerve as in head injuries; an injury to a nerve trunk permitting the rapid absorption of a large amount of toxin; the production of a meagre amount of toxin or the presence of something which prevents the admission of a large amount of toxin into the circulation.

Axhausen[1] reports eleven cases in man, with but a single death, in which distinct local tetanic symptoms preceded the usual manifestations. After studying these cases he concluded that they had a long incubation period averaging twenty days, that the symptoms were slow to develop and likewise to decline. In Table I will be found ten cases in which local manifestations in the part injured preceded the other evidences of tetanus.[2] Three of them resulted from head or face injuries, all recovering; two were blank cartridge wounds of the hand, one recovering; one a lacerated hand; two gunshot wounds of the thigh; one due to an abrasion of the shin; and one to a penetrating wound of the foot. The two latter recovered. The average incubation period of this group was only 9.2 days, however. Six of them recovered, showing a mortality of only 40 per cent. Our cases, therefore,

[1] Deutsche Zeitschrift f. Chirurgie, 1905, 78, 265.

[2] Table I *a*, Cases 16, 17, 24, 28, 42, 45. Table I *b*, 7, 21. Table I *c*, 8. Table I *d*, 2.

verify in the main the statements of Axhausen, although the mortality was considerably higher.

Classification of Cases. Recognizing the fact as previously stated that the length of the incubation period is as a rule a good index of the virulence of the infection, for the purpose of estimating the value of the serum treatment we have divided the cases herewith submitted into two classes and shall speak of those as acute in which the incubation period was less than ten days' duration, and of those as subacute when it was ten days or longer.

Believing that it is but natural that men would as a rule be more apt to publish their successes than their failures, we have not attempted to collect from literature the cases of tetanus which have been subjected to serum treatment. Two tables, however, are presented. The first represents the experiences gathered from many of the large hospitals of the United States. It is believed that as the table includes all of the cases treated at the institutions, and in a few instances in the private practice of their surgeons, a truer estimate of the real worth of the antitoxic serum could thus be obtained. The second covers all of the cases treated in New York State in which the State Department of Health furnished antitoxin. The data for this group of cases are furnished by Dr. Pease, one of the writers of this paper, who is the director of the antitoxin laboratory of this State.

In Table I there are 144 cases, in Table II 59, placing at our command 203 cases. Of those in Table I, 66 were treated by subcutaneous injection; 48 by injection of the serum into various structures; 12 by intraspinal; 16 by intramuscular; one by intracerebral, and one by intravenous injection.

Of the 59 cases in Table II, 42 were treated subcutaneously; 16 by injection into different tissues, and 1 by intracerebral injection.

In Table I there were 93 acute cases, the termination being known in 91. Of these 78 died, a mortality of 85.7 per cent.

The number of subacute cases in this table is 44. The final result is given in 43. There were 15 deaths, a mortality of 34.9 per cent. In six the incubation period is not mentioned.

In Table II the termination was given in 36 acute cases; 29 died, mortality 80.6 per cent. Of 21 subacute cases in which the result is given there were 11 deaths, a mortality of 52.4 per cent.

The mortality attending the various methods of administering the antitoxin shows the following in Table I:

Of 66 cases treated by subcutaneous injections, the incubation period is not mentioned in one case. Of the remaining 65, 47 were acute cases, the termination being known in 46. Of these 38 died, mortality 82.6 per cent.; 18 were subacute, of which but four died, mortality 22.2 per cent.

In 48 cases treated by a combination of either subcutaneous, intraneural, intraspinal, intravenous or intracranial injections, the result is mentioned in 47. Of these 30 were acute, the termination being known in 29; 27 dying, a mortality of 93.1 per cent.; 14 were subacute cases, of whom 7 died, mortality 50 per cent.

By intraspinal injection 12 were treated, in one the incubation period not being stated; seven were acute cases, 4 dying, mortality 57.1 per cent. In three subacute cases, in which the result was known, all recovered. Of 16 cases treated by intramuscular injection, in one the incubation period is not given. Of the remaining 15, 7 were acute, all dying; mortality 100 per cent. Of the remaining 8 subacute cases, 4 died; mortality 50 per cent.

In Table II a study of the cases results as follows: By subcutaneous injection 42 were treated; the incubation period was known in 40, and of this number 24 were acute, of whom 19 died; mortality 79.2 per cent. Of the 16 subacute cases thus treated 7 died; mortality 43.8 per cent.

Sixteen were treated by the injection of the antitoxin into the several structures mentioned in a previous paragraph. Eleven were acute cases, 9 dying; mortality 81.8 per cent.; while of 5 subacute cases four died, a mortality of 80 per cent.

In each table there is recorded a single case treated by intracerebral injection alone. Both patients died.

In Table I there appears one acute case treated by intravenous injection. This patient died.

The tables were carefully analyzed for the purpose of studying the degree of virulence of the cases treated by the different methods, and it appears that a larger percentage of cases with a short period of incubation, rapid progress and an early death, were treated by subcutaneous injection than by any other method.

As to the amount of antitoxin injected, in but 20 cases were more than 500 c.c. administered. These cases had an average incubation period of 10.8 days; 15 recovered and 5 died, a mortality of 25 per cent. Five of the 15 recovering had short periods of incubation. The treatment was begun in these cases on an average 3.3 days after the appearance of tetanic symptoms and the average length of its continuance was 7.4 days. The largest amount of antitoxin given a single patient was 1495 c.c. Of the 20 cases seven are found in Table I, with two deaths, mortality 28.6 per cent.; and 13, with three deaths, mortality 23 per cent., in Table II.

It is apparent that the amount of antitoxin administered to these patients is not the only factor to be considered in their recovery, for as a group they belong to the subacute class.

It should be stated that in most of the cases included in our tables medicinal treatment was given in addition to the serum. Occasionally it will be noted that the reporter has commented to the effect that he attributes in a given case quite as much to the drugs as to the serum.

Reference might here be made to the paper by Anders and Morgan.[1] It is based upon 252 cases, in 115 of which the antitoxic serum was used. But the details of its use are so meagrely stated that we are not able to estimate its worth in the cases quoted. A few of these cases appear in our Table I. However, their conclusions as to the value of serum therapy do not differ materially from those we are compelled to reach.

Treatment of Tetanus. From the facts here presented, it is apparent that after tetanus is fully established serum therapy, however administered, promises but little as a curative agent.

[1] Jour. Amer. Med. Assoc., July 29, 1905.

A word as to the special methods of injection. The intracerebral method first practised with apparent success by Roux and Borrel[1] experimentally in animals was received for a short time with favor by the profession. The results obtained by it were not particularly encouraging. The two cases reported in our tables as having been treated by intracerebral injection alone, both died. Table I*b* contains a list of 11 cases treated by a combination of subcutaneous and intracranial injections. Four of these cases received also intravenous injections. Of the 11 thus treated, but one recovered, a mortality of 91 per cent.

The method has nothing particularly to commend itself as a means of reaching either the free toxin or that fixed to cells of the nervous system. Moreover, it is not devoid of danger, as in the case reported by Gibb[2] first as cured and later[3] as having died of cerebral abscess. At the autopsy each frontal bone contained an abcess cavity, the left one communicating with the left lateral ventricle, and through the great transverse fissure with the cerebellar fossæ. Every effort was made, we are assured, to perform the operation aseptically. The serum was believed to have been sterile. The suppurating condition was attributed to the frequent repetition of the injection.

The injection of tetanus antitoxin into the subdural space by means of lumbar puncture was devised by Blumenthal and Jacob.[4] This method has been used extensively. Without carefully analyzing the cases in our table I *c*, we might be led to estimate the value of this method above its real worth. It should be noted, however, that two of the cases had an incubation period of twenty-one and twenty-six days, respectively, both recovering, and that in the four cases reported by Luckett, all of whom recovered, the reporter lays greater stress upon the withdrawal of the cerebrospinal fluid than upon the injection of the antitoxin. This was done because the claim is made that it is rich in toxin and that by

[1] Annales d l'Institut Pasteur, 1898, 12, 225.
[2] British Med. Journal, April 15, 1899.
[3] Ibid., July 1, 1899.
[4] Berliner klinische Wochenschrift, 1898, 32, 1079.

its withdrawal a large amount of toxin is removed. That this assumption is unwarranted appears from the investigations of Jacob and Blumenthal,[1] Meyer and Ransom,[2] Millian and Legros.[3] Luckett withdrew 161 m., 605 m., 1556 m., and 3610 m. of spinal fluid in these cases respectively. Moreover, it will be noted that in two of his cases local tetanus preceded the general manifestations, a condition which we have shown indicates a mild attack of tetanus; while a third case (No. 9 of this table) it appears to us cannot be absolutely regarded as one of tetanus, and his fourth case is to be classed as subacute, judged by the incubation period.

The injection of antitoxin into the subdural space offers but little prospect of reaching the affected nerve cells because of the protection offered by the pia mater. It has been demonstrated that even the tetanus toxin injected into the subarachnoid space does not reach the nerve cells directly.

For this reason it has been suggested that the antitoxin be carried more deeply, and that it be introduced either into the cord or the cauda equina. Rogers[4] has practised this method in connection with intraneural and intravenous injections in six cases, with three recoveries. A seventh case included in his report occurred in a patient who punctured his left wrist with a hook July 2, 1904, and the palm of his right hand with the same hook July 10, 1904. He was not admitted into the hospital until August 10, 1904, so that there was an incubation period of not less than thirty-one and it might have been as long as thirty-nine days. This patient received a single injection into the nerve trunks of each upper extremity of five and ten minims respectively and 10 c.c. subcutaneously in the neighborhood of the wound in each extremity. It seems to us that this case should be considered apart from the others. Of the other three recoveries one had an incubation period of sixteen days and ran a mild course, while the other two were acute cases and the results obtained were most gratifying.

[1] Berlin. klin. Wochensch., 1898, 49.
[2] Loc. cit.
[3] Soc. de Biol., March, 1901.
[4] Journal of Amer. Med. Assoc., July 1, 1905.

The three fatal cases were all due to crushing wounds of the extremities; two having incubation periods of ten and eleven days, respectively, and one of six days.

Meyer and Ransom[1] recommended that attempts be made to neutralize the toxin present in the large nerve-trunks by the injection of antitoxin into them, and reported one case in which an attack of local tetanus was relieved by the injection of antitoxin into the motor nerves controlling the tetanized region.

Kuster[2] reported to the German Surgical Congress at its session in 1905, a similar case of localized tetanus which was relieved by injections of the proper nerves. In reviewing this case he expressed the opinion that intraneural injections could be of benefit only while tetanus is localized. Kocher and other German surgeons in the course of the discussion endorsed this view, agreeing that only the toxin present in the injected nerve could be thus neutralized. It is even doubtful whether it is possible to neutralize any considerable portion of the toxin in a given nerve by intraneural injections. Fletcher[3] has shown very definitely that it is not an easy matter to inject a nerve trunk so that any large number of its axis-cylinders become exposed to the fluid injected. In several of his experiments in which toxin was injected into nerves the poison passed directly into the lymph spaces of the endoneurium and did not reach any of the axis-cylinders, for no tetanus resulted. Only when he injured a considerable number of the axis-cylinders of the nerve by his injection did he succeed in producing absorption of the toxin by the axones.

Theoretically, if antitoxin comes in contact with a marked number of the axis-cylinders of an injected nerve trunk the symptoms in the region controlled by that nerve should cease very shortly and not recur. This is what took place in Kuester's case, for there occurred a subsequent painful myositis of the muscles supplied by the injected nerves. Intraneural injections no doubt interrupt the current through the axis-cylinders because of the mechanical pressure they produce, and thus prevent the absorption of the toxin for the time being.

[1] Loc. cit. [2] Abstract of proceedings of German Surgical Congress, 1905.
[3] Brain, 1903, 26, 383.

But a word is necessary, in conclusion, to summarize the results of serum therapy in the light of the laboratory studies referred to and the clinical experiences herewith submitted. As a prophylactic measure it merits our fullest confidence, but as a therapeutic agent after tetanus is fully established we are forced to admit that as yet no method has been discovered whereby it can be administered so as to reach effectively the toxin not free in the blood or lymph.

CASES OF TETANUS TREATED IN HOSPITALS OR BY HOSPITAL SURGEONS WITH ANTITOXIC SERUM ADMINISTERED BY SUBCUTANEOUS INJECTION.

CASE 1.—KEEFE, Rhode Island Hospital. Age 23. Punctured wound of foot by rusty nail. Tetanus bacilli found. Period of incubation, 5 days; trismus—rigidity of cervical muscles; general convulsions 3 days later; treatment began second day; continued 2 days. Subcutaneous injection of antitoxic serum, first day: 2 injections, 30 c.c. each, = 60 c.c.; second day: 5 injections, 60 c.c. each, = 300 c.c. Total amount injected, 360 c.c. Death on third day after admission.

CASE 2.—HERSEY, Rhode Island Hospital. Age 51. Small punctured wound of scalp; rusty nail. Tetanus bacilli found. Period of incubation, 7 days; trismus; general convulsions next morning; treatment began first day; continued 1 day. Subcutaneous injection of antitoxic serum, one injection, 40 c.c. Total amount injected, 40 c.c. Sudden convulsion next morning and death.

CASE 3.—MUNRO, Rhode Island Hospital. Age 10. Blank cartridge wound of hand; 4th of July accident. Period of incubation, 8 days; trismus; stiffness cervical and spinal muscles; treatment began third day; continued 1 day Subcutaneous injection of antitoxic serum, in several injections, 300 c.c. Total amount injected, 300 c.c. Course and termination unknown.

CASE 4.—HERSEY, Rhode Island Hospital. Age 44. Two fingers crushed by falling log. Period of incubation, 21 days; moderate trismus and rigidity of neck, slight opisthotonos; general convulsions frequent but slight; treatment began first day; continued 4 days. Subcutaneous injection of antitoxic serum, 8 injections daily, 40 c.c. Total amount injected, 1280 c.c. Dismissed cured after 20 days.

CASE 5.—GODDING, Rhode Island Hospital. Age 59. Burn of both feet, second degree. Tetanus bacilli found. Period of incubation, 9 days; delirium, trismus; treatment began second day; continued 1 day. Subcutaneous injection of antitoxic serum, 2 injections, 20 c.c. each. Total amount injected, 40 c.c. Death one-half hour after second injection.

CASE 6.—MUNRO, Rhode Island Hospital. Age 55. Right thumb crushed working in lumber yard. Period of incubation, 5 days; trismus; general convulsions 2 days later; treatment began on second day; continued 1 day. Subcutaneous injection of antitoxic serum, 1 injection, 20 c.c. Total amount injected, 20 c.c. Death three and a half hours later.

CASE 7.—MITCHELL, Rhode Island Hospital. Age 50. Wound of bridge of nose; fall on stairs. Period of incubation, 12 days; 7 days after injury slight twitching of jaw muscles—disappeared; trismus twelfth day; treatment began

third day; continued 10 days. Subcutaneous injection of antitoxic serum, first day, 1 injection, 40 c.c.; second to ninth days, every 6 hours, 20 c.c. Total amount injected, 760 c.c. Left hospital on 25th day; weak and with slight trismus persisting.

CASE 8.—ROSWELL PARK; private patient. Age 21. Toy pistol; second finger left hand. No tetanus bacilli found. Period of incubation, 10 to 11 days; trismus; soreness muscles back of neck; dysphagia; treatment began second day; continued about 15 days. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, first day, 3 injections, 10 c.c. = 30 c.c.; afterwards 1 to 2 injections, 10 c.c. each until 27 had been given. Total amount injected, 270 c.c. Recovered.

CASE 9.—M. W. RAYNOR, Newark City Hospital, Newark, N. J. Age 11. Punctured wound of foot; rusty nail. Tetanus bacilli found. Period of incubation, 8 days; trismus, extreme opisthotonos, T. = 101°–102.5°, dysphagia, general pain, retained urine, delirium; general convulsions; treatment began on first day; continued 12 days. P. D. & Co.'s and Mulford's antitoxin used. Subcutaneous injection of antitoxic serum, first day, one injection, 40 c.c.; second to seventh days, every 4 hours, 30 c.c.; next 2½ days, every 6 hours, 20 c.c.; last 2 days, every 8 hours, 10 c.c. Total amount injected, 1380 c.c. Recovered.

CASE 10.—GEO. TULLY VAUGHAN, Emergency Hospital, Washington, D. C. Age 27. Punctured wound left foot; rusty nail. Period of incubation, 7 days; trismus; stiffness of neck, cramps in abdomen, weak mucous râles; P. = 90-120; T. = 99°-102°; general convulsions; treatment began fourth day; continued 4 days. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, 15 injections of 20 c.c. each in 4 days. Total amount injected, 300 c.c. Pneumonia on sixth day and death on eighth day.

CASE 11.—GEO. TULLY VAUGHAN, Emergency Hospital, Washington, D. C. Age 59. Compound comminuted fracture left leg; wound suppurated. Period of incubation, 11 days; trismus, dysphagia; treatment began on second day; continued 2 days. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, 7 injections in 2 days, 20 c.c. each. Total amount injected, 140 c.c. Death in severe general convulsions on second day.

CASE 1 .—GEO. TULLY VAUGHAN, Emergency Hospital. Washington, D. C. Age 33. Punctured wound sole of foot; nail. Period of incubation, 5 days; trismus, rigidity of abdomen and back; general convulsions; treatment began on second day; continued 1 day. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, 8 injections; 25 c.c. every 3 hours. Total amount injected, 200 c.c. Death 24 to 36 hours after appearance of symptoms.

CASE 13.—GEO. TULLY VAUGHAN; private. Age 25. Calf right leg impaled on rusty hook. Period of incubation, 7 days; complete trismus, next day cramps in abdomen; treatment began on second day; continued 1 day. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, 8 injections; 25 c.c. q. 3 hours. Total amount injected, 200 c.c. Death on third day.

CASE 14.—C. B. G. DE NANCREDE, University of Michigan Hospital. Age 16. While working in livery barn stepped on nail. Puncture wound of right foot. Period of incubation, 7 days; felt ill on seventh day; pronounced tetanic convulsions ninth day after injury; treatment began on fourth day; continued 3 days. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, 18 injections; 10 c.c. q. 4 hours. Total amount injected, 180 c.c. Leg amputated; death on sixth day.

CASE 15.—C. B. G. DE NANCREDE, University of Michigan Hospital. Age 15. Contused wound from explosion of cannon cracker, 4th of July. Tetanus bacilli found. Period of incubation, 6 days; fifth day pain in region of œsophagus; sixth day, trismus; general convulsions; treatment began first day; continued 1 day. P. D. & Co. s antitoxin used. Subcutaneous injection of antitoxic serum, 6 injections; 10 c.c. q. 4 hours. Total amount injected, 60 c.c. Arm amputated; death on third day.

CASE 16.—LEONARD FREEMAN, St. Joseph's Hospital, Denver, Col. Age 55. Superficial excoriation of skin. No tetanus bacilli found. Period of incubation, 21 days; cramps in leg; trismus; right arm cramped; T. = 99°–100°; treatment began on third day; continued 2 days. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, 15 c.c., repeated in 6 hours, and twice thereafter at 8 hour intervals. Total amount injected, 60 c.c. Recovery; attributed to medicines given and not to serum.

CASE 17.—PATCH, Montreal General Hospital. Age 27. Lacerated wound, bridge of nose, abrasion of face. No tetanus bacilli found. Period of incubation, 6 days; fourth day—twitching, both sides of face, stiffness of eyelids; fifth day, worse; sixth day, trismus; no stiffness of neck muscles, superficial reflexes normal; (entered hospital this day); T. = 102°–104°; later stiffness of neck and back; some opisthotonos; treatment began on third day. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, first injection, 20 c.c.; afterwards every 6 hours—27 injections. Total amount injected, 300 c.c. At first grew worse, then gradual improvement and ultimate recovery.

CASE 18.—JOHN C. MUNRO, Boston; private. Age 19. Lacerated finger; crushed by door. No tetanus bacilli found. Period of incubation, 9 days; ninth day, sore throat, headache and dysphagia; eleventh day, trismus, and later (same day) opisthotonos; treatment began on second day; continued 2 days. Subcutaneous injection of antitoxic serum given by attending physician; amount not known. Death.

CASE 19.—F. E. BUNTS, Cleveland; private. Age 10. Lacerated right eyebrow and lid. Fall from street car—dirt ground in. No tetanus bacilli found. Period of incubation, 9 days; ninth day, moderate degree of trismus; tenth day, swallowing water produced violent spasm and opisthotonos; general convulsions; treatment began on second day; continued 1 day. Subcutaneous injection of antitoxic serum, 10 c.c. q. 4 hours, 6 injections. Total amount injected, 60 c.c. Death on third day.

CASE 20.—DUDLEY P. ALLEN, Lakeside Hospital, Cleveland, Ohio. Age 18. Blank cartridge wound of hand. Tetanus bacilli found. Period of incubation, 7 days; painful spasms of face, neck, back, and extremities; hypersensitive; treatment began first day; continued 36 hours. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, 7 injections; 10 c.c. q. 4 hours. Total amount injected, 70 c.c. Death after 36 hours.

CASE 21.—DUDLEY P. ALLEN, Lakeside Hospital, Cleveland, Ohio. Age 12. Blank cartridge wound of hand. Part of wad still in hand on admission. No tetanus bacilli found. Period of incubation, 8 days; muscles of lower jaw, face, neck and abdomen rigid on admission; general convulsions; treatment began on second day; continued 6 days. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, 20 injections, 10 c.c. q. 6 hours for 5 days. Total amount injected, 200 c.c. Death on seventh day.

CASE 22.—DUDLEY P. ALLEN, Lakeside Hospital, Cleveland, Ohio. Age 13. Blank cartridge, left hand. Opened, cauterized, packed, July 4th. No tetanus bacilli found. Period of incubation, 7 days; neck stiff; throat felt queer; not marked on admission; treatment began on first day; continued 5 days. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, 18 injections; 10 c.c. q. 6 hours for 5 days. Total amount injected, 180 c.c. Death on fifth day.

CASE 23.—DUDLEY P. ALLEN, Lakeside Hospital, Cleveland, Ohio. Age 8. Blank cartridge wound of scrotum. Admitted on seventh day. No tetanus bacilli found. Period of incubation, 7 days; head retracted; trismus; general convulsions; treatment began on first day; continued 1 day. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, single injection, 5 c.c. Total amount, 5 c.c. Death following morning, 2 A.M.

CASE 24.—DUDLEY P. ALLEN, Lakeside Hospital, Cleveland, Ohio. Age 8. Blank cartridge wound palm of right hand. No tetanus bacilli found. Period of incubation, 7 days; slight contractions fingers injured hand; charac-

teristic cry at intervals; next day head retracted; slight trismus; treatment began first day; continued 2 days. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, 8 injections, 10 c.c. q. 6 hours. Total amount injected, 80 c.c. Death on third day.

Case 25.—Ed. H. Ochsner, Augustana Hospital, Chicago. Age 12. Gunshot wound through hypothenar eminence left hand. No tetanus bacilli found. Period of incubation, 13 days; moderate degree trismus and opisthotonos; treatment began first day; continued 2 days. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, 10 c.c. at 6 and 11 P.M. Next day 8 A.M., 3 P.M., 11.30 P.M., and 10 A.M. following day. Total amount injected, 60 c.c. Gradual recovery.

Case 26.—Emmet Rixford, Lane Hospital, San Francisco. Age 35. Punctured wound of foot. Patient farm hand. Nail passed through shoe. No tetanus bacilli found. Period of incubation, 12 days; facial contortion first, then mild trismus and spasm of trapezius, neck and abdomen; treatment began eleventh day; continued 3 days. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, 7 injections q. 10 c.c. Total amount injected, 70 c.c. Chloral and bromides also used. Recovery in 27 days.

Case 27.—Emmet Rixford, Lane Hospital, San Francisco. Age 14. Lacerated wound of leg opening knee; compound fracture fibula. Head of bone covered with manure. No tetanus bacilli found. Period of incubation, 7 days; violent spasms including respiratory tract—opisthotonos; general convulsions; treatment began second day; continued 3 days. P. D. & Co.'s and Pasteur Institute antitoxin used. Subcutaneous injection of antitoxic serum, second day, 10 c.c.; third day, 20 c.c.; fourth day, 10 c.c. Total amount injected, 40 c.c. Death on fourth day.

Case 28.—Emmet Rixford, Lane Hospital, San Francisco. Age 50. Perforating wound of lower lip. No tetanus bacilli found. Period of incubation, 7 days; mild—limited to face and neck; so mild that diagnosis questioned; no general convulsions; treatment began second day; continued 6 days. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, for 3 days q. 6 hours, and following 6 days q. 12 hours, 10 c.c. at each injection. Total amount injected, 180 c.c. Sodium bromide also given. Marked erythema. Recovery.

Case 29.—Geo. E. Brewer, Roosevelt Hospital, New York. Lacerated wound of posterior and inner right arm; caught in machinery cogs. No tetanus bacilli found. Period of incubation, 19 days; mild trismus; no dysphagia; opisthotonos 2 days later following incision; treatment began second day; continued 10 days. New York City Board of Health's antitoxin used. Subcutaneous injection of antitoxic serum, first injection 10 c.c. into abdominal muscles, then q. 6 hours for 7 days, 10 c.c. On eighth and ninth days 2 injections 10 c.c. and on tenth day 1. Total amount injected, 340 c.c. Gradual improvement. Recovery in 47 days.

Case 30.—Geo. E. Brewer, Roosevelt Hospital, New York. Age 28. Elliptical incision, site of appendectomy wound 5 years old. Incision for ventral hernia. No tetanus bacilli found. Period of incubation, 11 days; eleventh day, trismus; twelfth day, rigidity of arms and neck; very weak; later same day total rigidity; treatment began first day; continued 1 day. New York City Board of Health's antitoxin used. Subcutaneous injection of antitoxic serum, 4 injections, 15 c.c. q. 4 hours into abdomen. Total amount injected, 60 c.c. Death on third day.

Case 31.—B. F. Curtiss, Bellevue Hospital, New York. Age 43. Compound comminuted gunshot wound of anterior side of foot. No tetanus bacilli found. Period of incubation, 7 days; stiffness lower jaw, next day almost complete trismus, by night stiffness of back; general convulsions; third day very severe; controlled by chloroform; treatment began first day; continued 3 days. Subcutaneous injection of antitoxic serum, first day, at 4 P.M., 9 P.M. and 12 P.M., 20 c.c.; second day, 6 injections q. 20 c.c.; third day, 20 c.c. q. 4 hours. Total amount injected, 300 c.c. Death on third day.

CASE 32.—H. B. WILLIAMS, New York Hospital. Age 14. Blank cartridge wound of hand, July 4th, 1904. Tetanus bacilli found. Period of incubation, 9 days; mild at first, rapidly becoming severe; general convulsions; treatment began second day; continued 6 days. New York City Board of Health's antitoxin used. Subcutaneous injection of antitoxic serum, second day, 6 P.M., 10 c.c., 9 P.M., 15 c.c., 12 P.M., 15 c.c.; third day, 6 A.M., 10 c.c., 12 M., 40 c.c.; fourth day, 40 c.c.; sixth day, 2 injections of 30 c.c.; seventh day, 30 c.c. Total amount injected, 220 c.c. Death; for 36 hours before death no convulsions—just before death opisthotonos and severe spasm.

CASE 33.—H. B. WILLIAMS, New York Hospital. Age 38. Hand crushed while working in streets. No tetanus bacilli found. Period of incubation, 3 days; mild at first, then very severe; general convulsions; treatment began second day; continued 1 day. New York City Board of Health's antitoxin used. Subcutaneous injection of antitoxic serum, 20 c.c. at 10 A.M., 12:30 P.M., and 10 P.M. Total amount injected, 60 c.c. Death on second day.

CASE 34.—H. B. WILLIAMS, New York Hospital. Age 13. Punctured wound of foot. No tetanus bacilli found. Period of incubation, 9 days; trismus, retraction and stiffness of neck; treatment began on eighth day; continued 6 days. New York City Board of Health's antitoxin used. Subcutaneous injection of antitoxic serum, eighth day, 25 c.c.; ninth, 20 c.c.; tenth, 25 c.c.; eleventh, 20 c.c., 25 c.c.; twelfth, 20 c.c.; thirteenth, 20 c.c. Total amount injected, 155 c.c. Gradual improvement; discharged well after 31 days' sickness (27 days after admission).

CASE 35.—J. P. WARBASSE, German Hospital, Brooklyn, N. Y. Age 8. Blank cartridge wound of hand. No tetanus bacilli found. Period of incubation, 6 days; trismus and opisthotonos; T. = 104°; treatment began on first day; continued 1 day. New York City Board of Health's antitoxin used. Subcutaneous injection of antitoxic serum 10 c.c. every 2 hours. Total amount injected, 120 c.c. T.° rose to 108.6° before death on third day. Death.

CASE 36.—J. P. WARBASSE, German Hospital, Brooklyn, N. Y. Age 43. Supravaginal hysterectomy, double oöphorectomy. Incision, 4-5 inches. No tetanus bacilli found. Period of incubation, 6 days; trismus, dysphagia, rigidity of cervical muscles, later opisthotonos; general convulsions; treatment began on first day; continued 1 day. New York City Board of Health's antitoxin used. Subcutaneous injection of antitoxic serum, 3 injections, q. 8 hours, 20 c.c. Total amount injected, 60 c.c. Death.

CASE 37.—J. P. WARBASSE, German Hospital, Brooklyn, N. Y. Age 14. Gunshot wound of foot. No tetanus bacilli found. Period of incubation, 7 days; characteristic; treatment began on first day; continued 1 day. New York City Board of Health's antitoxin used. Subcutaneous injection of antitoxic serum, 3 injections, 20 c.c. q. 8 hours. Total amount injected, 60 c.c. Death.

CASE 38.—J. P. WARBASSE, German Hospital, Brooklyn, N. Y. Age 13. Punctured wound of sole of foot by nail. No tetanus bacilli found. Period of incubation, 4 days; pain in chest, then trismus, pain in neck with rigidity; general convulsions; treatment began on third day. New York City Board of Health's antitoxin used. Subcutaneous injection of antitoxic serum, injections q. 6 hours. How long not stated. Recovery.

CASE 39.—J. P. WARBASSE, German Hospital, Brooklyn, N. Y. Age 12. Lacerated wound, hand. No tetanus bacilli found. Characteristic. New York City Board of Health's antitoxin used. Subcutaneous injections of antitoxic serum administered daily, given in injections of 20 c.c. q. 12 hours. Length of period of treatment omitted. Death.

CASE 40.—J. P. WARBASSE, German Hospital, Brooklyn, N. Y. Age 10. Blank cartridge wound of right hand. No tetanus bacilli found. Period of incubation, 8 days; slow development; cramp-like pain between scapulæ; then stiffness legs, right arm; trismus. On entering hospital right arm in convulsions. New York City Board of Health's antitoxin used. Subcutaneous injection of antitoxic serum, 10 c.c. q. 6 hours. How long not mentioned. Recovery.

Case 41.—J. P. Warbasse, German Hospital, Brooklyn, N. Y. Age 28. Punctured wound left foot; nail. No tetanus bacilli found. Period of incubation, 7 days; virulent; stiffness of muscles of neck and face, trismus, involuntary defecation. New York City Board of Health's antitoxin used. Subcutaneous injection of antitoxic serum, details not furnished. T.° rose to 108.6° before death on third day.

Case 42.—Chas. H. Goodrich, Methodist Episcopal Hospital, Brooklyn, N. Y. Age 23. Right hand lacerated by buzz saw. No tetanus bacilli found. Period of incubation, 14 days; pain in hand, stiffness jaws, neck and abdomen; head retracted; general convulsions; treatment began on third day; continued 3 days. Gibier's antitoxin used. Subcutaneous injection of antitoxic serum third, fourth, and fifth days; 9 doses, 1 q. 8 hours, 8½ c.c. Total amount injected, 75 c.c. Serum treatment discontinued as patient grew worse. Death on seventh day.

Case 43.—Chas. H. Goodrich, Methodist Episcopal Hospital, Brooklyn, N. Y. Age 29. Punctured wound of foot from nail. Period of incubation, 6 days; rigidity of jaw; advanced rapidly; pain in back; dysphagia; opisthotonos; general convulsions; treatment began on fourth day; continued 2 days. New York City Board of Health's antitoxin used. Subcutaneous injection of antitoxic serum, fourth day, 2 injections, 20 c.c. and 12 c.c. Fifth day, 2 injections 20 c.c. each. Total amount injected, 72 c.c. Death on sixth day in sudden and severe convulsions.

Case 44.—Chas. H. Goodrich, Methodist Episcopal Hospital, Brooklyn, N. Y. Age 56. Colectomy for cancer splenic flexure. Anastomosis with bobbin of raw potato. No tetanus bacilli found. Period of incubation, 10 days; eighth day, great abdominal pain; tenth day, choking sensation and dysphagia; trismus and neck rigidity followed; general convulsions; treatment began on first day; continued 2 days. Brooklyn Health Department's antitoxin used. Subcutaneous injection of antitoxic serum, first day, in evening, 20 c.c.; second day, A.M., 20 c.c.; P.M., 30 c.c. Total amount injected, 70 c.c. Death during tenth severe general convulsion on second day.

Case 45.—Hall and Clopton, St. Louis; private. Age 55. Penetrating wound of sole of right foot. No tetanus bacilli found. Period of incubation, 13 days; spasms in right leg extending up into thigh; next, trismus with dysphagia; symptoms of mild type; treatment began on first day; continued 10 days. Subcutaneous injection of antitoxic serum, 1 injection of 10 c.c. daily for 10 days. Total amount injected, 1000 c.c. Wound excised first day. Disease lasted 12 days. Mild. Recovery.

Case 46.—J. C. Morfit, St. Louis; private. Age 30. Penetrating wound of toe; rusty nail. No tetanus bacilli found. Period of incubation, 7 days; severe; extreme trismus; treatment began on first day; continued 1 day. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, 1 injection, "large amount." Very severe case. Death on first day.

Case 47.—J. C. Morfit, Mullanphy Hospital, St. Louis. Age 19. Gunshot wound left hand. Had intercurrent tonsillitis. Tetanus bacilli found. Period of incubation, 11 days; risus sardonicus, dysphagia, stiffness of neck, abdomen and extremities; opisthotonos; general convulsions; treatment began on first day; continued 10 days. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, first day, 6 injections; second day, 3; third day, 2; fourth day, 2; fifth to tenth days, 1 daily, all of 10 c.c. Total amount injected, 190 c.c. Recovery. "I have seen a more severe case recover without any treatment."

Case 48.—Wm. J. Taylor, St. Agnes Hospital, Philadelphia. Age 8. Punctured wound (healed) in palm of hand; nail. No tetanus bacilli found. Period of incubation, 6 days; entered hospital second day; stiffness of neck and back, trismus, marked convulsions, opisthotonos, risus sardonicus; general convulsions; treatment began on first day; continued 1 day. Subcutaneous injection of antitoxic serum, first day, 30 c.c. about noon. Total amount injected 30 c.c. Discharged cured on third day.

Case 49.—Jas. Tyson, Pennsylvania Hospital, Philadelphia. Age 53. Healed punctured wound plantar surface right foot. No tetanus bacilli found. Period of incubation, 9 days; trismus, rigidity of cervical muscles and those of jaw, back and abdomen; admitted fifth day; treatment began on fifth day; continued 1 day. Mulford's antitoxin used. Subcutaneous injection of antitoxic serum, 30 c.c. given about wound, and 30 c.c. and later 60 c.c. into abdomen. Total amount injected, 120 c.c. Death 24 hours after admission.

Case 50.—Alfred Stengel Pennsylvania Hospital, Philadelphia. Age 27. Burn of arm (coal oil). No tetanus bacilli found. Period of incubation, 25 days; admitted 30 days after injury; profound trismus; slightest noise would produce general convulsions with opisthotonos; general convulsions; treatment began fifth day; continued 1 day. Mulford's antitoxin used. Subcutaneous injection of antitoxic serum, 3 injections 40 c.c. each; 9 A.M., 12 M. and 4 P.M. Total amount injected, 120 c.c. After 3 doses, carbolic acid injections given. Gradual recovery. Well in 25 days.

Case 51.—Halsted's Clinic, Johns Hopkins Hospital, Baltimore. Age 52. Punctured wound sole of foot, rusty nail. Period of incubation, 7 days; admitted second day; stiffness neck and jaws; almost absolute trismus; risus sardonicus; rigid abdominal muscles; treatment began on second day; continued 1 day. Subcutaneous injection of antitoxic serum, 30 c.c. injected into axilla and 20 c.c., summary. Total amount injected, 50 c.c. Death on day of admission.

Case 52.—C. A. Porter, Massachusetts General Hospital. Age 55. Compound fracture right ankle. Leg amputated day before first symptoms. Period of incubation, 6 days; rigid neck; T. 105°; dysphagia; no general convulsions; treatment began on second day; continued 1 day. Subcutaneous injection of antitoxic serum, 20 c.c. q. 4 hours. Death on third day.

Case 53.—C. A. Porter, Massachusetts General Hospital. Age 29. Multiple lacerated dynamite wounds from knee to jaw right side of body. No tetanus bacilli found. Period of incubation, 7 days; dysphagia, rapid increase in severity; T. 100.2°, P. 68, R. 22; treatment began on first day; continued 1 day. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum 20 c.c. q. 4 hours. Total amount injected, 80 c.c. Death in 17 hours.

Case 54.—C. A. Porter, Massachusetts General Hospital. Age 16. Blank cartridge wound of finger. Period of incubation, 6 days; opisthotonos, diaphragmatic breathing, trismus, dysphagia; T. 100.4°, P. 124, R. 22; treatment began second day; continued 1 day. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, 30 c.c. in pectoral region repeated in 6 hours and again in 4 hours. Total amount injected, 90 c.c. Death in 18 hours.

Case 55.—C. A. Porter, Massachusetts General Hospital. Age 11. Blank cartridge wound of palm. Tetanus bacilli found. Period of incubation, 9 days; slight risus, slight retraction of head; T. 100.5°, P. 84; treatment began on second day; continued 4 days. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, 10 c.c. q. 4 hours increasing to 20 c.c. q. 2 hours on last day. Death on sixth day.

Case 56.—C. A. Porter, Massachusetts General Hospital. Age 36. Blank cartridge wound left hand. No tetanus bacilli found. Period of incubation, 7 days; masseters, neck and abdominal muscles stiff; T. 99.8°, P. 70, R. 28; treatment began on second day; continued 2 days. Subcutaneous injection of antitoxic serum, 20 c.c. q. 4 hours. Doubled amount on second day. Death on third day.

Case 57.—C. A. Porter, Massachusetts General Hospital. Age 10. Blank cartridge wound left side thorax. No tetanus bacilli found. Period of incubation, 7 days; convulsions; no lung symptoms or dyspnœa; T. 102°, P. 150, R. 35; general convulsions; treatment began on second day; continued 1 day. Subcutaneous injection of antitoxic serum, 5 c.c., 15c.c., 20 c.c. q. 3 hours. Death on second day.

Case 58.—C. A. Porter, Massachusetts General Hospital. Age 11. Blank cartridge wound, left palm. Tetanus bacilli found. Period of incubation, 7

days; trismus and dysphagia; T. 99.8°, P. 92, R. 18; treatment began on second day; continued 3 days. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, 40 c.c. on entrance, 10 c.c. q. 3 hours. Death on fourth day. T. 108°.

Case 59.—C. A. Porter, Massachusetts General Hospital. Age 13. Compound fracture of forearm. No tetanus bacilli found. Period of incubation, 7 days; very severe; T. 104.8°, P. 140, R. 27; general convulsions every 20 seconds; treatment began on second day; continued 1 day. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, 30 c.c. after amputation of arm, 20 c.c. 6 hours later. Total amount injected, 50 c.c. Death in 23 hours.

Case 60.—C. A. Porter, Massachusetts General Hospital. Age 27. Punctured wound foot; nail. No tetanus bacilli found. Period of incubation, 14 days; mild at first, gradually increasing; T. 104°, P. 72, R. 23; no general convulsions; treatment began on second day. Subcutaneous injection of antitoxic serum, 20 c.c. q. 6 hours. Gradual recovery in 23 days.

Case 61.—C. A. Porter, Massachusetts General Hospital. Age 9. Blank cartridge wound, hand. No tetanus bacilli found. Period of incubation, 10 days; trismus, spasms of flexors of hand, opisthotonos on stimulation; T. 100.6°, P. 112, R. 25; general convulsions; treatment began on second day; continued 4 days. Subcutaneous injection of antitoxic serum, every 4 hours for 4 days in varying amounts. Discharged after 33 days.

Case 62.—C. A. Porter, Massachusetts General Hospital. Age 28. Blank cartridge wound, left hand. Period of incubation, 7th day; trismus and rigidity muscles neck and abdomen; T. 100°, P. 80, R. 22; no general convulsions. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, 10 c.c. q. 4 hours. Recovery in 26 days. Never had convulsions.

Case 63.—James Bell, Royal Victoria Hospital, Montreal. Age 29. Punctured wound of sole of foot; rusty nail. Period of incubation, 6 days; stiffness of jaw and back muscles; jolting caused spasms; later, spasms of muscles of abdomen and extremities; risus sardonicus; general convulsions; treatment began on fifth day; continued 2 days. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, first day, 10 c.c. subcutaneously; second day, 10 c.c. subcutaneously. Total amount injected, 20 c.c. Death on seventh day.

Case 64.—James Bell, Royal Victoria Hospital, Montreal. Age 18. Punctured wound of foot; nail. Period of incubation, 8 days; stiffness of jaw, dysphagia, constricted feeling in chest; treatment began on fifth day; continued 6 days. Gibier's and Roux's antitoxin used. Subcutaneous injection of antitoxic serum, sixth day: 11:30 A.M., 1 c.c.; 5:30 P.M., 1 c.c. Seventh day: 11 A.M., 1 c.c.; 6 P.M., 10 c.c. Eighth day: 6 A.M., 10 c.c.; 12 M., 25 c.c.; 6 P.M., 25 c.c. Ninth day: 12 P.M., 25 c.c.; 6 A.M., 25 c.c.; 12 M., 10 c.c. Tenth day: 12 P.M., 10 c.c.; 12 M., 25 c.c.; 6 P.M., 25 c.c. Eleventh day: 12 P.M., 85 c.c. Total amount injected, 278 c.c. Death on eleventh day.

Case 65.—James Bell, Royal Victoria Hospital, Montreal. Age 42. Compound fracture tibia and fibula left leg. Tetanus bacilli found. Period of incubation, 10 days; stiffness of jaws, dysphagia, risus sardonicus, rigidity of abdominal muscles, rectal tenesmus, spasms of muscles of face; treatment began on second day; continued 19 days. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, second day: 3 P.M., 30 c.c.; 11 P.M., 20 c.c. Third to eighth days, 20 c.c. daily; ninth day, 10 c.c.; fifteenth day, 20 c.c.; eighteenth day, 20 c.c.; twenty-first day, 20 c.c. Total amount injected, 240 c.c. Recovery in 44 days.

Case 66.—James Bell, Royal Victoria Hospital, Montreal. Slight superficial cut on palm of left hand. No tetanus bacilli found. Period of incubation, 12 days; dysphagia, face swollen, backache, constricted feeling in chest, opisthotonos; injured hand flexed at wrist, thumb adducted; general convulsions; treatment began on second day; continued 1 day. Subcutaneous injection of antitoxic serum, 10 c.c. into wound and 20 c.c. into right loin on admission; 12 M., 40 c.c. into left loin. Total amount injected, 70 c.c. Recovery.

CASES OF TETANUS TREATED IN HOSPITALS OR BY HOSPITAL SURGEONS WITH ANTITOXIC SERUM INJECTED INTO VARIOUS STRUCTURES.

CASE 1.—ROSWELL PARK, Buffalo General Hospital. Age 10. A punctured wound of sole of foot, by tack. Period of incubation, 8 days; marked tetanus and opisthotonos; treatment began on second day; continued 1 day. Subcutaneous injection of antitoxic serum, 30 c.c., at 7 P.M.; 23 c.c., 11 P.M. Intraneural injection, 3 c.c., into sciatic; 3 c.c., into anterior crural. Intraspinal injection at two places, each 12 c.c. Total amount injected, 83 c.c. Death one-half hour after second injection.

CASE 2.—GEO. T. VAUGHAN, Emergency Hospital, Washington, D. C. Age 25. Thumb and two fingers destroyed by burn. Dressed with ichthyol and iodoform. Period of incubation, 16 days; trismus, abdominal rigidity, opisthotonos; general convulsions; treatment began first day; continued 4 days. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, 20 c.c. q. 4 hours for first 2 days. Intravenous injection, 1st day 10 c.c. Intracranial, 3rd and 4th days 30 c.c. daily under dura. Total amount injected, 310 c.c. Death on 4th day.

CASE 3.—H. B. GESSNER, Charity Hospital, New Orleans, La. Age 18. Railroad injury to right foot and laceration of the scalp. Period of incubation, 11 days; severe; temperature, 102°; general convulsions; treatment began on second day; continued one day. P. D. & Co's. antitoxin used. Subcutaneous injection of antitoxic serum, 10 c.c. into foot. Intraspinal, 162 m. Total amount injected, 21 c.c. Convulsions disappeared in 10 days, cured in 34 days.

CASE 4.—S. LOGAN, Charity Hospital, New Orleans, La.; service Dr. Matas. Age 13. Toy pistol wound on right hand. Period of incubation, 8 days; mild, slight opisthotonos, few convulsions; general convulsions; treatment began on first day; continued 3 days. P. D. & Co's. antitoxin used. Intraneural injection, perineural 50 c.c. Intraspinal injection, 10 c.c. Total amount injected, 60 c.c. Course and termination not stated.

CASE 5.—C. B. G. DE NANCREDE; private patient. Age 18. Severe injury of foot. Early manifestations of tetanus not stated. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, 10 c.c. q. 4 hours. Intraneural injection, at time of amputation into severed nerve trunks; intraspinal injection, at time of amputation. Amputation through middle of leg. Recovery.

CASE 6.—PATCH, Montreal General Hospital. Age 5. Traumatic amputation of thigh; bone and muscles protruding. No tetanus bacilli found. Period of incubation, 9 days; admitted second day unconscious, trismus, opisthotonos; T. 99.2°–104.4°; general convulsions, 2; treatment began second day; continued 1 hour. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, 10 c.c. Intraspinal injection, 20 c.c. Intracranial, 10 c.c. Total amount injected, 40 c.c. Death 1 hour after injections.

CASE 7.—PATCH, Montreal General Hospital. Age 16. Laceration of forehead. Period of incubation, 8 days; trismus and dysphagia gradually increasing for 6 days; on admission spastic gait, head retracted to left, trismus, paralysis of tongue, respiratory distress. rt. facial paralysis; treatment began on sixth day; continued 2 days. Roux's antitoxin used. Subcutaneous injection of antitoxic serum, 5 c.c. on sixth day. Intraspinal injection, sixth day, 10 c.c.; seventh day, 15 c.c. Total amount injected, 30 c.c. Improvement began 4 days after admission. Up 10 days later. Recovery.

CASE 8.—PATCH, Montreal General Hospital. Age 5. Small wound on sole of foot, healed, enclosing drop pus. No tetanus baccilli found. Period of incubation, 10 to 14 days; stiffness neck and arms in morning; 10 P.M., general convulsions, opisthotonos; next day trismus, twitching face, all muscles in tonic convulsions, T. 98°; general convulsions; treatment began second day; con-

tinued 15 hours. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, 10 c.c. first; intraspinal injection later, 10 c.c. Total amount injected, 20 c.c. Death 15 hours after first injection. T.° 109°.

Case 9.—Wm. M. Mastin, Mobile City Hospital, Mobile, Ala. Age 35. Following abortion. No tetanus bacilli found. Period of incubation, 7 to 8 days; mild trismus, muscular rigidity, opisthotonos; general convulsions; treatment began on second day; continued 5 days. Mulford's antitoxin used. Subcutaneous injection of antitoxic serum, third to sixth days, 20 c.c. q. 4 to 8 hours. Intraspinal injection, second day, 20 c.c. Total amount injected, 400 c.c. Morphine and chloral also given. Recovery.

Case 10.—Dudley P. Allen, Lakeside Hospital, Cleveland. Age 26. Blank cartridge wound, hand; healing. No tetanus bacilli found. Period of incubation, 7 days; trismus; during next 48 hours muscles of neck, back and legs rigid; treatment began first day; continued 1 day. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, 5 c.c. Intracranial, 2½ c.c. into each lateral ventricle. Total amount injected, 10 c.c. T. rose from 100° to 109° (axillary). Death on fourth day.

Case 11.—Dudley Tait, French Hospital, San Francisco. Age 27. Slight abrasion received in cleaning hides. No tetanus bacilli found. Period of incubation, 6 days; acute, characteristic symptoms; entered hospital second day; treatment began second day; continued 3 days. P. D. & Co.'s antitoxin used. Intravenous injection, several of 8 c.c. on third day. Intracranial injection, second day, 1 and 1½ c.c. in each frontal lobe. Death on fourth day.

Case 12.—Dudley Tait, San Francisco; private patient. Age 26. Lacerated wound left index finger. Period of incubation, 14 days; subacute; general convulsions; treatment began on first day; continued 5 days. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, first day 4 injections, 20 c.c., afterwards 2 injections daily. Intravenous injection, first day, 4 injections 1½ c.c., afterwards 2 daily. Total amount injected, 36 c.c. Death.

Case 13.—Dudley Tait, San Francisco; private patient. Age 30. Wound, right hand (stable man). No tetanus bacilli found. Period of incubation, 10 days; mild; general convulsions; treatment began first day; continued few days. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, 2 injections first day, repeated daily. Intravenous injection, 2 injections first day, repeated daily. Recovery.

Case 14.—Geo. E. Brewer, Roosevelt Hospital, New York City. Age 14. Blank cartridge wound base of left forefinger. No tetanus bacilli found. Period of incubation, 6 days; severe trismus; head retracted; general convulsions with opisthotonos and spasms of extremities; general convulsions; treatment began first day; continued 2 days. N. Y. C. B. of H.'s antitoxin used. Subcutaneous injection of antitoxic serum, first day, 20 c.c. Intravenous injection, second day, 20 c.c. Total amount injected, 40 c.c. Death second day.

Case 15.—Geo. E. Brewer, Roosevelt Hospital, New York City. Age 21. Infected blank cartridge wound base left forefinger. No tetanus bacilli found. Period of incubation, 8 days; some trismus, stiffness back of neck, painful dysphagia, opisthotonos; general convulsions; treatment began second day; continued 10 days. N. Y. C. B. of H.'s antitoxin used. Subcutaneous injection of antitoxic serum, second day, 4 doses; third day, 6 doses; fourth day, 2 doses; fifth day, 2 doses; sixth day, 3 doses; seventh day, 4 doses; eighth day, 3 doses; ninth day, 4 doses; tenth day, 3 doses; each 20 c.c. Intravenous injection, fifth day, 4 doses 20 c.c. Total amount injected, 640 c.c. Dyspnœa and cyanosis third day with dysphagia and strangling. No symptoms until seventh day. Then rigidity of muscles. Later became comfortable. Death twelfth day.

Case 16.—Geo. E. Brewer, Roosevelt Hospital, New York City. Age 24. Compound fracture ulna with lacerated elbow. No tetanus bacilli found. Period of incubation, 7 days; trismus, pain back of neck, opisthotonos, involuntary micturition; treatment began first day; continued 2 days. Subcutaneous injec-

tion of antitoxin serum, first day, 60 c.c. Intravenous injection, first day, 40 c.c. with 1.000 c.c. saline solution; same second day. Total amount injected, 140 c.c. Death on second day.

Case 17.—Henry Heiman, Mt. Sinai Hospital, New York. Age 12. Penetrating wound right foot; nail. Tetanus bacilli found. Period of incubation, 11 days; severe rigidity, neck, back and legs; trismus, hyperacusis; treatment began third day; continued 8 days. N. Y. C. B. of H.'s antitoxin used. Subcutaneous injection of antitoxic serum, 8 injections, 20 c.c. Intraspinal injection, 3 injections of 20 c.c. Total amount injected, 220 c.c. Recovery. Question if due to serum.

Case 18.—A. V. Moschcowitz, Mt. Sinai Hospital, New York. Age 18. Blank cartridge, palm hand. No tetanus bacilli found. Period of incubation, 7 days; mild at first, increasing in severity; treatment began second day; continued 2 days. Antitoxin of Institute Pasteur, Paris, used. Intravenous injection, second day, 2 injections of 20 c.c. and 10 c.c. Intracranial injection, third day, 5 c.c. Total amount injected, 35 c.c. Death.

Case 19.—Willy Meyer, German Hospital, New York. Age 27. Appendectomy through rectus muscle. No tetanus bacilli found. Period of incubation, 10 days; trismus, pain in muscles of jaw; rigidity and pain in muscles of neck, risus sardonicus, opisthotonos, dysphagia; treatment began second day; continued 6 days. Subcutaneous injection of antitoxic serum, third day, 10 c.c.; seventh and eighth days, 10 c.c.; ninth day, 15 c.c. Intraspinal injection, second day, 2½ c.c.; third day, 10 c.c.; fifth day, 12 c.c. and 15 c.c. Total amount injected, 84½ c.c. Gradual recovery.

Case 20.—Fred Kammerer, German Hospital, New York. Age 38. Appendectomy during quiescent period. Primary incision. Tetanus bacilli found. Period of incubation, 9 days; very severe, risus sardonicus, rigidity muscles neck, abdomen; later paralysis muscles deglutition, rigidity of intercostals; general convulsions; treatment began first day; continued 11 days. N. Y. C. B. of H.'s antitoxin used. Subcutaneous injection of antitoxic serum, first day, 30 c.c.; sixth, seventh, eighth, ninth, tenth, eleventh days, 2 injections of 30 c.c. Intraspinal injection, second day, 15 c.c. Intravenous injection, third, fourth and fifth days, each, 30 c.c. Total amount injected, 495 c.c. Improvement for 9 days, then increase in symptoms. Death twelfth day.

Case 21.—H. B. Williams, Hudson St. House of Relief, N. Y. City. Age 12. Blank cartridge wound left thigh; suppurating; 4th July, 1899. Period of incubation, 4 days; stiffness of thigh, 5 days later trismus, risus sardonicus, opisthotonos; general convulsions; treatment began seventh day; continued 1 day. Subcutaneous injection of antitoxic serum, seventh day, 20 c.c. Intracranial injection, seventh day, 5 c.c. into each frontal lobe. Total amount injected, 30 c.c. Death on eighth day.

Case 22.—H. B. Williams, Hudson St. House of Relief, N. Y. City. Age 13. Blank cartridge wound base of left thumb. Dressed 5 hours after injury; no subsequent dressing. Period of incubation, 5 days; sudden stiffness jaw, next day mild opisthotonos and marked trismus; general convulsions; treatment began second day; continued 1 day. N. Y. C. B. of H.'s antitoxin used. Subcutaneous injection of antitoxic serum, 50 c.c. Intracranial injection, 10 c.c. into each lateral ventricle. Total amount injected, 70 c.c. Death on third day.

Case 23.—H. B. Williams, New York Hospital. Age 54. Compound fracture of leg. Amputated at hospital 6 days later. No tetanus bacilli found. Period of incubation, 9 days; trismus; treatment began first day; continued 1 day. N. Y. C. B. of H.'s antitoxin used. Intravenous injection, 20 c.c. in 450 c.c. salt solution. Intracranial injection into each lateral ventricle. Total amount injected, 20 c.c. +. Death on second day. Leg amputated 6 days after injury.

Case 24.—H. B. Williams, New York Hospital. Age 17. Blank cartridge wound palm right hand. No tetanus bacilli found. Period of incubation, 6 days; trismus and mild risus sardonicus; treatment began second day; con-

tinued 11 days. N. Y. C. B. of H.'s antitoxin used. Subcutaneous injection of antitoxic serum, second day, into chest and abdomen, 20 c.c.; fourth day, q. 6 hours, 20 c.c., 10 c.c., 20 c.c.; fifth day, 20 c.c. Intraspinal injection, sixth to twelfth days inclusive, daily 20 c.c. Intravenous injection, third day, 50 c.c. Total amount injected, 290 c.c. Death on twelfth day.

Case 25.—R. R. Canna, King's County Hospital, Brooklyn. Age 40. Rusty nail from stable into foot. No trouble locally with wound. Tetanus bacilli found. Period of incubation, 4 days; entered hospital seventh day, trismus had been present 3 days, opisthotonos; general convulsions; treatment began fourth day; continued 1 day. N. Y. C. B. of H.'s antitoxin used. Subcutaneous injection of antitoxic serum, 20 c.c. Intraspinal injection, 40 c.c. Total amount injected, 60 c.c. Foot amputated; death in coma day after admission.

Case 26.—R. R. Canna, King's County Hospital, Brooklyn. Age 22. R. R. traumatic amputation right thigh. Tetanus bacilli found. Period of incubation, 8 days; difficulty in opening mouth; trismus followed delirium; opisthotonos; treatment began first day; continued 15 days. N. Y. C. B. of H.'s antitoxin used. Subcutaneous injection of antitoxic serum, 40 c.c. first day. Intraspinal injection, 15 c.c., first day; 20 c.c. each day subsequently until death. Total amount injected, 335 c.c. Death on fifteenth day.

Case 27.—Geo. Pickerell, U. S. N., U. S. Naval Hospital, San Juan, Porto Rico. Age 22. Punctured wound inner side right leg, just below knee. Period of incubation, 10 days; ninth day coryza with soreness and stiffness of jaws; tenth day symptoms marked; eleventh day pronounced trismus, on auscultation murmur over muscles jaw, neck and chest; general convulsions, eleventh day, 1 of fifteen minutes, thirteenth day, 3; treatment began second day; continued 6 days. "French" antitoxin used. Subcutaneous injection of antitoxic serum, second day, 10 c.c.; third day, 20 c.c.; fourth, fifth, sixth, each 20 c.c. Intracranial injection, third day right lateral ventricle and subdural, each 3 c.c. Total amount injected, 100 c.c. After fourth day gradual improvement. Recovery 55 days after injury.

Case 28.—J. B. Carnett, Philadelphia Hospital. Age 9. Nail perforated shoe; punctured wound of sole. No tetanus bacilli found. Period of incubation, 6 days; admitted second day; trismus 24 hours' duration; general convulsions 12 hours before; general spastic condition of muscles; general convulsions; treatment began second day; continued few hours. Mulford's antitoxin used. Subcutaneous injection of antitoxic serum, 30 c.c. Intraneural injection, 30 c.c. into great sciatic at gluteal fold. Intraspinal injection, 35 c.c. Total amount injected, 95 c.c. Given at one time under anæsthetic. Death 3 hours later.

Case 29.—Jas. Tyson, Pennsylvania Hospital, Philadelphia. Age 27. No wound except that of tongue bitten during first convulsion 4 days before. Retained placenta found at autopsy. No tetanus bacilli found. On admission, trismus, general muscular rigidity, increased reflexes; general convulsions; treatment began fourth day; continued 1 day. Mulford's antitoxin used. Subcutaneous injection of antitoxic serum, 10 c.c., later, 20 c.c. Intraspinal injection, 20 c.c., later, 30 c.c. Total amount injected, 80 c.c. Death 24 hours after admission into hospital.

Case 30.—Jas. Tyson, Pennsylvania Hospital, Philadelphia. Age 26. Small punctured wound right foot; rusty nail. No tetanus bacilli found. Period of incubation, 6 days; only painful mastication; reflexes increased; seventh day, general muscular rigidity; ninth day, convulsions; general convulsions; treatment began first day; continued 2 days. Mulford's antitoxin used. Subcutaneous injection of antitoxic serum, first day, 30 c.c. over sciatic nerve; later, again, 30 c.c.; second day, q. 4 hours 60 c.c. Intraspinal injection, first day, 30 c.c. Total amount injected, 420 c.c. Death on third day.

Case 31.—Halsted's Clinic, Johns Hopkins Hospital, Baltimore, Md. Age 43. Punctured wound left great toe; rusty nail. Tetanus bacilli found. Period of incubation, 8 days; stiffness muscles jaw and neck; progressed rapidly to

opisthotonos; general convulsions; treatment began second day; continued 5 days. Subcutaneous injection of antitoxic serum deep into thigh muscles twice daily for several days, 10 c.c. Intracranial injection, once, 5 c.c. into each frontal lobe. Total amount injected, 90 c.c. Death on seventh day.

Case 32.—Halsted's Clinic, Johns Hopkins Hospital, Baltimore, Md. Age 50. Gangrene right foot from frost bite; amputation. No tetanus bacilli found. Five days after admission retraction head; 2 hours later opisthotonos, risus sardonicus; 3 hours later general convulsions; injection of antitoxic serum, 5 c.c. into thigh muscles first day and 15 c.c. second day, 5 c.c. under skin. Intravenous injection, 10 c.c. second day. Total amount injected, 35 c.c. Death on second day.

Case 33.—Nathan Jacobson, St. Joseph's Hospital, Syracuse, N. Y. Blank cartridge wound right hand July 4th, 1899. Wound opened on admission to hospital and wad removed. No tetanus bacilli found. Period of incubation, 7 days; admitted on fourth day with trismus, stiffness neck muscles and general convulsions; general convulsions; treatment began fourth day; continued 2 days. Subcutaneous injection of antitoxic serum, fourth day, 2 injections, 10 c.c. Intracranial injection, fifth day, twice, 10 c.c. Total amount injected, 40 c.c. Death, 7 A.M on sixth day.

Case 34.—H. B. Williams, Hudson St. House of Relief, N. Y. City. Age 22. Punctured wound left foot; rusty nail. No tetanus bacilli found. Period of incubation, 5 days; stiffness of neck and jaw muscles; treatment began fifth day; continued 1 day. N. Y. City Health Department's antitoxin used. Subcutaneous injection of antitoxic serum, 1 injection, 10 c.c. Intraspinal injection, 1 injection 10 c.c. Total amount injected, 20 c.c. Death on sixth day of disease; one day after admission.

Case 35.—C. A. Porter, Massachusetts General Hospital. Age 13. Blank cartridge wound, left palm. Tetanus bacilli found. Period of incubation, 4 days; pain in back of neck, trismus; risus sardonicus; convulsions; general convulsions; treatment began on fourth day; continued 1 day. P. D. & Co.'s antitoxin used. Intraneural injection, median and ulnar at wrist, 1 c.c.-3 c.c. Intraspinal injection, 11 c.c. twice. Total amount injected, 26 c.c. Death 16 hours after admission.

Case 36.—C. A. Porter, Massachusetts General Hospital. Age 10. Cannon cracker wound, right arm. Tetanus bacilli found. Period of incubation, 4 days; trismus, convulsions, dysphagia; T. 100.2°, P. 110, R. 30; general convulsions; treatment began second day; continued 1 day. P. D. & Co.'s antitoxin used. Subcutaneous injection about wound. Intraneural injection into roots of brachial plexus. Death 16 hours after admission.

Case 37.—C. A. Porter, Massachusetts General Hospital. Age 15. Blank cartridge wound, right palm. Tetanus bacilli found. Period of incubation, 7 days; admitted second day; trismus, risus sardonicus, convulsions, pain in neck and abdomen, diaphragmatic breathing; general convulsions; treatment began second day; continued 1 day. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum every 4 hours. Intraneural injection, median and ulnar at wrist, 4½ c.c. each. Intraspinal injection every 6 hours. Death 17 hours after admission.

Case 38.—C. A. Porter, Massachusetts General Hospital. Age 17. Knife cut second and third fingers. Period of incubation, 3 weeks; stiffness in jaws and neck, pain in back; T. 102.2°, P. 90; general convulsions; treatment began on second day; continued 1 day. Intraneural injection into brachial plexus, 5 c.c. Intraspinal injection, 10 c.c. Total amount injected, 15 c.c. Death on third day.

Case 39.—C. A. Porter, Massachusetts General Hospital. Age 17. Wound right leg, cannon cracker. Tetanus bacilli found. Period of incubation, 7 days; general slight rigidity, marked trismus; T. 101°, P. 96, R. 28; treatment began third day; continued 2 days. P. D. & Co.'s and Massachusetts State B. of H.'s antitoxin used. Subcutaneous injection of antitoxic serum, 20 c.c.

Intravenous injection, 30 c.c. in salt solution; 50 c.c. q. 6 hours, second day. Total amount injected, 200 c.c. Death 48 hours after admission.

Case 40.—C. A. Porter, Massachusetts General Hospital. Age 17. Blank cartridge wound of hand. Tetanus bacilli found. Period of incubation, 7 days; severe general convulsions; T. 102.8°, P. 152, R. 28; general convulsions; treatment began on first day; continued 2 hours. Subcutaneous injection of antitoxic serum, 10 c.c. Intracranial injection, 3 c.c., into each lateral ventricle. Total amount injected, 16 c.c. Death in 2½ hours.

Case 41.—C. A. Porter, Massachusetts General Hospital. Age 33. Punctured wound of foot; nail. No tetanus bacilli found. Period of incubation, 5 days; trismus, moderate degree; T. 99.2°, P. 88, R. 22; general convulsions; treatment continued 3 days. Subcutaneous injection of antitoxic serum, 10 c.c. q. 4 hours. Intracranial injection, 3 c.c., into each lateral ventricle, second day. Total amount injected, 186 c.c. Death 72 hours after admission.

Case 42.—C. A. Porter, Massachusetts General Hospital. Age 73. Frozen toe. No tetanus bacilli found. Period of incubation, 2 weeks; trismus, risus sardonicus; general convulsions; treatment began first day; continued 8 hours. Pasteur Institute antitoxin used. Intravenous injection, 40 c.c., twice. Intracranial injection, 3 c.c. into each frontal lobe and 2 c.c. under dura. Total amount injected, 90 c.c. Death 8 hours after admission.

Case 43.—C. A. Porter, Massachusetts General Hospital. Age 56. Nail wound, right heel. Period of incubation, 2 weeks; risus and tense abdomen; no general convulsions; treatment began fourth day. Subcutaneous injection of antitoxic serum, 20 c.c. Intraneural injection, 1 c.c. into anterior crural and sciatic. Death on fifteenth day. Not due to tetanus but to bed sores, etc.

Case 44.—C. A. Porter, Massachusetts General Hospital. Age 18. Machine crushed second and third fingers. Tetanus bacilli found. Period of incubation, 13 days; trismus; pain in abdomen; T. 101.6°, P. 90, R. 24; general convulsions; treatment began second day. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, 10 c.c. q. 12 hours. Intraneural injection, musculospiral, median, and ulnar nerves injected, 10 c.c. each. Intraspinal injection, 10 c.c. twice. Total amount injected, 60 c.c. +. Recovery. Discharged thirtieth day.

Case 45.—W. J. Roe, Jefferson Medical College Hospital. Age 14. Appendectomy during quiescent period. No tetanus bacilli found. Period of incubation, 9 days; dull pain in head and neck, trismus, retraction of head, risus sardonicus, opisthotonos, dysphagia, tonic rigidity muscles of abdomen and extremities; general convulsions; treatment began first day; continued 6 days. Mulford's antitoxin used. Subcutaneous injection of antitoxic serum, 1230 c.c. Intraspinal injection, 175 c.c. antitoxin and 13 c.c. of a 25 per cent. $MgSO_4$ solution. Intravenous injection, 90 c.c. Total amount injected, 1495 c.c. Death.

Case 46.—James Bell, Royal Victoria Hospital, Montreal. Lacerated wrist; glass. Tetanus bacilli found. Period of incubation, 11 days; stiffness and numbness in fingers of injured arm; next day, trismus; fingers flexed into palm; treatment began first day; continued 18 days. Subcutaneous injection of antitoxic serum, first, second and third days, 20 c.c.; fourth to seventh days, 60 c.c. daily. Intraspinal injection, seventeenth day, 10 c.c.; eighteenth day, 10 c.c. Total amount injected, 320 c.c. Recovery in 31 days.

Case 47.—James Bell, Royal Victoria Hospital, Montreal. Age 9. Contusion and laceration of skin over tibia. Tetanus bacilli found. Period of incubation, 47 days; sore tongue, weak, backache, spastic condition lower extremities and retraction of head; general convulsions; treatment began *first day after injury*, 4 days after first symptoms; continued 1 day. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, 5 c.c. *first day after injury as a prophylactic;* fourth day of disease, 10 c.c. Intraneural injection, 7 c.c. into anterior crural. Intraspinal injection, 7 c.c. Total amount injected, 29 c.c. Death on fifth day.

Case 48.—James Bell, Royal Victoria Hospital, Montreal. Age 5. Infected vaccination wound. Tetanus bacilli found. Period of incubation, 23 days; stiffness arm and jaw, neck stiff, painful, sternomastoid contracted (operation), opisthotonos, numerous spasms; general convulsions; treatment began first day; continued 1 day. P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, 10 c.c., 4 c.c., 10 c.c. Intraneural injection, 4 c.c. into sheath of musculo-spiral, musculo-cutaneous, and ulnar; enough to swell median 3 times its natural size was injected. Intraspinal injection, 4 c.c.; later, 4 c.c. by cervical puncture; still later, 10 c.c. as above. Intravenous injection, 4 c.c. Total amount injected, 58 c.c. +. Death on second day.

CASES OF TETANUS TREATED IN HOSPITALS OR BY HOSPITAL SURGEONS ADMINISTERED BY INTRASPINAL INJECTION WITH ANTITOXIC SERUM.

Case 1.—R. Matas, New Orleans; private patient. Age 24. Vaccination. Period of incubation, 17 days; severe tonic spasm of all voluntary and respiratory muscles; treatment began first day. P. D. & Co.'s antitoxin used. Intraspinal injection of antitoxic serum administered daily, 50 c.c. Total amount injected, 50 c.c. Result not stated.

Case 2.—Dudley P. Allen, Lakeside Hospital, Cleveland, Ohio. Age 10. Lacerated wound left heel; cut with glass 4 weeks before admission, nearly healed. Period of incubation, 26 days; trismus, neck arched, opisthotonos; hypersensitive; general convulsions; treatment began third day; continued 12 days. P. D. & Co.'s antitoxin used. Intraspinal injection of antitoxic serum administered daily, 10 c.c. q. 6 hours for 5 days; 10 c.c. q. 8 hours for 1 day; 10 c.c. once daily for 6 days. Total amount injected, 290 c.c. Left hospital in 4 weeks, well.

Case 3.—Dudley P. Allen, Lakeside Hospital, Cleveland, Ohio. Age 9. Boy running barefoot, number scratches and cuts on feet. Tonic convulsions, head thrown back, opisthotonos, extremities rigid; general convulsions; treatment began first day; continued 5 days. P. D. & Co.'s antitoxin used. Intraspinal injection of antitoxic serum administered daily, 10 c.c. q. 8 hours. Total amount injected, 150 c.c. Death on fifth day.

Case 4.—Dudley P. Allen, Lakeside Hospital, Cleveland, Ohio. Age 14. Small punctured wound right foot; nail. No tetanus bacilli found. Period of incubation, 8 days; trismus, opisthotonos, extremities rigid; treatment began first day; continued 36 hours. P. D. &. Co.'s antitoxin used. Intraspinal injection of antitoxic serum administered daily, 10 c.c. q. 6 hours. Total amount injected, 50 c.c. Death in 36 hours.

Case 5.—Dudley P. Allen, Lakeside Hospital, Cleveland, Ohio. Age 34. Three unclean wounds left hand; present 3 to 4 weeks. No tetanus bacilli found. Period of incubation, 21 days; 5 days before admission, pain in back and dizziness; 3 days before, pain and stiffness of back, trismus; day before, convulsions, opisthotonos, risus sardonicus; general convulsions; treatment began third day; continued 11 days. P. D. & Co.'s antitoxin used. Intraspinal injection of antitoxic serum administered daily, 10 c.c. q. 6 hours for 6 days, 240 c.c.; 10 c.c. once daily for 5 days, 50 c.c. Total amount injected, 290 c.c. Recovering.

Case 6.—Wallace I. Terry, San Francisco City and County Hospital. Age 32. Punctured wound outer side plantar aspect right foot; nail. No tetanus bacilli found. Period of incubation, 7 days; stiffness neck and trismus, general convulsions, first day, opisthotonos; general convulsions; treatment began on first day; continued 4 days. P. D. & Co.'s antitoxin used. Intraspinal injection of antitoxic serum administered daily, first day, 90 c.c.; second day, 30 c.c.; third day, 20 c.c.; fourth day, 19½ c.c. Total amount injected, 159½ c.c. Death on fourth day.

Case 7.—Willy Meyer, German Hospital, N. Y. City. Age 37. Superficial wound over right parietal; fell from elevated railroad. Immediate suture, suppuration, reopened. Period of incubation, 5 days; trismus; 4 days later tetanus; general convulsions; treatment began on seventh day; continued 1 day. N. Y. City Board of Health's antitoxin used. Intraspinal injection of antitoxic serum administered daily, single injection, 10 c.c. Total amount injected, 10 c.c. Death next day.

Case 8.—W. H. Luckett, Harlem Hospital, N. Y. City. Age 12. Blank cartridge wound right hand, July 4th. No tetanus bacilli found. Period of incubation, 7 days; stiffness in jaw, pain back neck, and right side chest; hand with claw-like contraction digits, abdominal muscles rigid; treatment began on second day; continued 12 days. N. Y. City Board of Health's antitoxin used. Intraspinal injection of antitoxic serum administered daily, second day, 8 c.c.; third day, 11 c.c.; fourth day, 12 c.c.; fifth day, 10 c.c.; sixth day, 12 c.c.; seventh day, 12 c.c.; eighth day, 15 c.c.; thirteenth day, 15 c.c. Spinal fluid withdrawn on second day, 22 m.; third day, 12 m.; fourth day, 5 m.; fifth day, 40 m.; sixth day, 2 m.; seventh day, 35 m.; eighth day, 45 m. Total, 161 m. withdrawn. Total amount injected, 92 c.c. Fifteenth day sat up in bed. Seventeenth day out of bed. Eighteenth day opened mouth. Nineteenth day discharged cured. 161 m. Cerebrospinal fluid withdrawn.

Case 9.—W. H. Luckett, Harlem Hospital, N. Y. City. Age 10. Left wrist cut on broken bottle while vaulting garden fence. Period of incubation, 5 days; on fifth day abdominal pain with tonic contraction muscles; treatment began second day; continued 5 days. N. Y. City Board of Health's antitoxin used. Intraspinal injection of antitoxic serum administered daily, once daily for 5 days, 9 c.c.–14 c.c. at a dose, first withdrawing cerebrospinal fluid. Total amount of spinal fluid withdrawn, 605 m. Total amount injected, 59 c.c. Sat up thirteenth day. Discharged well seventeenth day.

Case 10.—W. H. Luckett, Harlem Hospital, N. Y. City. Age 17. Blank cartridge wound, palmar surface right hand, July 4th. Period of incubation, 8 days; severe pain in head, dyspnœa, inability to articulate, muscular twitchings, trismus, rigid intercostals, abdomen rigid, left hand claw-like, contraction fingers, opisthotonos marked; general convulsions, 10; treatment began on second day; continued 4 days. N. Y. City Board of Health's antitoxin used. Intraspinal injection of antitoxic serum administered daily, once daily, each time preceded by withdrawal of cerebrospinal fluid, amounting in all to 1556 m. Injections each 18 c.c.–20 c.c. Total amount injected, 78 c.c. Gradual improvement, stiffness of legs last to disappear. Recovery in 1 month.

Case 11.—W. H. Luckett, Harlem Hospital, N. Y. City. Age 24. Blank cartridge wound, left hand, July 4th. No tetanus bacilli found. Period of incubation, 10 days; trismus, abdominal muscles rigid; general convulsions 4 days later; treatment began on fourth day; continued 9 days. N. Y. City Board of Health's antitoxin used. Intraspinal injection of antitoxic serum administered daily, on fourth, fifth, sixth and twelfth days, injection preceded by withdrawal of cerebrospinal fluid amounting to 3610 m. Injections of 20 c.c. each. Total amount injected, 80 c.c. Steady improvement, sat up in bed on fifteenth day. Discharged well on twentieth day.

Case 12.—H. G. Mudd, St. Luke's Hospital, St. Louis. Age 26. Small opening in left side scrotum, operation for varicocele. Tetanus bacilli found. Period of incubation, 7 days; very virulent; constant opisthotonos, with clonic spasms every few minutes; general convulsions; treatment began on second day; continued 1 day. Mulford's antitoxin used. Intraspinal injection of antitoxic serum administered daily, 1 injection, lumbar puncture. Total amount injected, 20 c.c. Death 16 hours after injection. Operation performed by man connected with advertising institution.

CASES OF TETANUS TREATED IN HOSPITALS OR BY HOSPITAL SURGEONS WITH ANTITOXIC SERUM ADMINISTERED BY INTRAMUSCULAR INJECTION.

CASE 1.—C. B. G. DE NANCREDE, University of Michigan Hospital. Age 17. Injury from moving train. Compound fracture occipital bone and compound comminuted fracture right hand. Tetanus bacilli found. Period of incubation, 11 days; difficulty in opening mouth, trismus and dysphagia, later slight localized spasm; treatment began on first day; continued 9 days. P. D. & Co.'s antitoxin used. Intramuscular injection of antitoxic serum, every 4 hours for 9 days 10 c.c. Total amount injected, 540 c.c. Amputation forearm second day. Recovery.

CASE 2.—J. SHELTON HORSLEY, Memorial Hospital, Richmond, Va. Age 25. Gunshot wound right thigh, fracturing femur. Period of incubation, 5 days; clonic spasm right thigh and leg; after 18 hours violent general convulsions; general convulsions; treatment began on first day; continued 4 days. Mulford's antitoxin used. Intramuscular injection of antitoxic serum, deep thigh injections attempting to enter nerves without exposing them, 10 c.c. every 8 hours. Total amount injected, 120 c.c. Death on fourth day.

CASE 3.—ANDREW SLOAN, St. Luke's, Utica. Age 12. Slight cartridge wound left hand. No tetanus bacilli found. Period of incubation, 11 days; trismus, tonic contractions muscles legs, back, abdomen, face, thorax, arms; second day; T. 102°–104°; treatment began on third day; continued 6 days. N. Y. S. D. of H.'s antitoxin used. Intramuscular injection of antitoxic serum administered daily, twice daily deep into thigh 60 c.c. Total amount injected, 720 c.c. Extensive urticaria. Additional medication, chloral, bromides, morphia. Gradual recovery.

CASE 4.—R. R. CANNA, King's County Hospital, Brooklyn. Age 49. Punctured wound of foot. Tetanus bacilli found. Trismus, clonic convulsions, opisthotonos. N. Y. City Board of Health's antitoxin used. Intramuscular injection of antitoxic serum administered daily, every 4 hours in doses of 20–40 c.c. Death in coma.

CASE 5.—R. R. CANNA, King's County Hospital, Brooklyn. Age 37. Punctured wound, foot; rusty nail. Tetanus bacilli found. Period of incubation. 3 days; difficult swallowing, trismus, opisthotonos; general convulsions; treatment began on third day; continued 1 day. N. Y. City Board of Health's antitoxin used. Intramuscular injection of antitoxic serum administered daily, every 4 hours 40 c.c. Total amount injected, 240 c.c. Death on fourth day in coma.

CASE 6.—R. R. CANNA, King's County Hospital, Brooklyn. Age 40. Rusty nail penetrated ball big toe. Mixed infection. Tetanus bacilli found. Period of incubation, 11 days; trismus, opisthotonos, unable to swallow; general convulsions, severe; treatment began on first day; continued 1 day. N. Y. City Board of Health's antitoxin used. Intramuscular injection of antitoxic serum 2 injections, each 40 c.c. Total amount injected, 80 c.c. Death second day after admission.

CASE 7.—ROBT. W. JOHNSON, Maryland General Hospital, Baltimore, Md. Age 18. Slight laceration palm left hand and powder burn, blank cartridge. Period of incubation, 5 days; stiffness of jaws, gradually growing worse, dysphagia; entered hospital third day; general convulsions; treatment began third day; continued 3 days. Mulford's antitoxin used. Intramuscular injection of antitoxic serum administered daily, injections 20 c.c. each; third day one, and one every 4 hours for next 3 days. Total amount injected, 380 c.c. Death on sixth day.

CASE 8.—HALSTED'S CLINIC, Johns Hopkins Hospital, Baltimore, Md. Age 28. Slough from burn, dorsum right foot; fell on stove during attack of epi-

lepsy. No tetanus bacilli found. Period of incubation, 15 days; stiffness jaw muscles, gradually growing worse; general convulsions on second, fourth and fifth days; treatment began on second day; continued 16 days. Intramuscular injection of antitoxic serum administered daily, second, third, fourth, and seventh to sixteenth days 10 c.c. once daily into thigh muscles, sixth day 2 injections each 10 c.c. Total amount injected, 140 c.c. Recovery. Gradual improvement. Discharge on sixteenth day.

Case 9.—Halsted's Clinic, Johns Hopkins Hospital, Baltimore, Md. Age 53. Punctured wound, foot. Rusty nail. Tetanus bacilli found. Period of incubation, 9 days; stiffness muscles neck, back; trismus moderate; rigidity muscles abdomen, back and neck; dysphagia; 1 slight convulsion; treatment began on second day; continued 6 days. Intramuscular injection of antitoxic serum, twice daily 60 m., increased to 70 m. twice daily deep into thigh. Total amount injected, 65 c.c. Death on seventh day.

Case 10.—Halsted's Clinic, Johns Hopkins Hospital, Baltimore, Md. Age 42. Contused and encrusted wound, bridge of nose. Period of incubation, 6 days; stiffness jaw, increasing to pronounced trismus, marked delirium and restlessness, pain and difficulty in breathing; treatment began on second day; continued 6 days. Intramuscular injection of antitoxic serum, second day once, after this twice daily 10 c.c. deep into thigh. Total amount injected, 110 c.c. Death on seventh day.

Case 11.—Halsted's Clinic, Johns Hopkins Hospital, Baltimore, Md. Age 40. End index finger cut off, sewed on and healed. Period of incubation, 10 days; stiffness jaws and neck; risus sardonicus; admitted fourth day of disease; treatment began on fourth day; continued 2 days. Intramuscular injection of antitoxic serum, on 4th day 30 c.c., on fifth day 20 c.c., deep into thigh. Total amount injected, 50 c.c. Death on sixth day.

Case 12.—Halsted's Clinic, Johns Hopkins Hospital, Baltimore, Md. Age 25. Punctured wound, sole right foot, rusty nail, incised 24 hours later. No tetanus bacilli found. Period of incubation, 10 days; admitted fourth day with trismus, general clonic spasms; general convulsions; treatment began on fourth day; continued 3 days. Intramuscular injection of antitoxic serum fourth day 10 c.c. on admission, after this 10 c.c. three times daily deep into thigh. Total amount injected, 100 c.c. Death on seventh day.

Case 13.—Halsted's Clinic, Johns Hopkins Hospital, Baltimore, Md. Age 18. Laceration, dorsal structures, left foot. Laceration great toe right foot. Amputation left foot and great toe of right foot within 2 hours after injury. No tetanus bacilli found. Period of incubation, 7 days; stiffness jaws and neck; general convulsions, rigid abdominal muscles; general convulsions; treatment began on first day; continued 5 days. Intramuscular injection of antitoxic serum, 20 c.c. daily deep into thigh muscles. Total amount injected, 100 c.c. Death on fifth day.

Case 14.—Halsted's Clinic, Johns Hopkins Hospital, Baltimore, Md. Age 21. Punctured wound, outer side sole right foot. Period of incubation, 25 days; stiffness of jaws; this disappeared; cramps in abdomen, opisthotonos, no rigidity arms or legs; convulsions; general convulsions; treatment began on first day; continued 4 days. Intramuscular injection of antitoxic serum first day 50 c.c. into muscles of thigh; second day 60 c.c. into muscles of thigh; third and fourth days 20 c.c. into muscles of thigh. Total amount injected, 150 c.c. No injections for 72 hours before death as there was apparent improvement. Then sudden death.

Case 15.—Halsted's Clinic, Johns Hopkins Hospital, Baltimore, Md. Age 8. Superficial clean granulating wound left ankle, 5 cm. in diameter, no foreign body, no suppuration. Period of incubation, 8 days; dysphagia, rigidity muscles neck, trismus, rigid abdomen; general convulsions; treatment began on second day; continued 1 day. Intramuscular injection of antitoxic serum, 20 c.c. into gluteal muscles. Total amount injected, 20 c.c. Death third day in violent convulsions.

CASE 16.—C. A. PORTER, Massachusetts General Hospital. Age 40. Traumatic amputation of fingers; axe. No tetanus bacilli found. Period of incubation, 13 days; stiffness of jaw, backache, slight risus; T. 99.2°, P. 102, R. 26; general convulsions, one; treatment began on fourth day. Intramuscular injection of antitoxic serum, 10 c.c. into deltoid q. 4 hours. Recovery in 21 days.

CASE OF TETANUS TREATED IN HOSPITALS OR BY HOSPITAL SURGEONS WITH ANTITOXIC SERUM ADMINISTERED BY INTRACEREBRAL INJECTION.

CASE 1.—Rhode Island Hospital. Age 24. Punctured wound, foot; rusty nail. Period of incubation, 6 days; continued 1 day. Intracerebral injection of antitoxic serum, 1 injection. Death 2 days after admission.

CASE OF TETANUS TREATED IN HOSPITALS OR BY HOSPITAL SURGEONS WITH ANTITOXIC SERUM ADMINISTERED BY INTRAVENOUS INJECTION.

CASE 1.—C. A. PORTER, Massachusetts General Hospital. Age 52. Following operation for removal uterine polyp. No tetanus bacilli found. Period of incubation, 7 days; risus; symptoms severe; emprosthotonos; T. 100°, P. 84, R. 17; treatment began first day; continued 2 days. Intravenous injection of antitoxic serum, 30 c.c.–40 c.c. q. 4 hours. Convulsions followed each injection. Death 48 hours after admission.

CASES OF TETANUS TREATED BY SUBCUTANEOUS INJECTION OF ANTITOXIN MADE AND FURNISHED BY THE NEW YORK STATE DEPARTMENT OF HEALTH.

CASE 1.—R. H. TEDFORD; private. Age 14. Blank cartridge wound of hand improperly dressed. Period of incubation, 5 days; general convulsions ninth day; treatment began on ninth day; continued 19 days. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxin administered daily, twice daily for first 10 days, once daily thereafter. 50 c.c. Total amount injected, 1350 c.c. Effect of antitoxin doubtful. Chronic case. Recovery.

CASE 2.—F. F. SMITH; private. Age 24. Five-inch cut by buzz saw which had been cutting old wood. Period of incubation, 11 days; stiffness of left leg 3 days before any other symptom; treatment began on fifth day; continued 7 days. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxin administered daily, 50 c.c. twice daily. Total amount injected, 700 c.c. Chronic case. Recovery.

CASE 3.—D. C. MORIATA; private. Age 14. Laceration of knee. Period of incubation, 18 days; stiffness of neck, jaw, face, and body; general convulsions seventh day; treatment began third day; continued 8 days. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxin administered daily, 100 c.c. once daily. Total amount injected, 800 c.c. Improvement after fifth injection. Chronic case. Recovery.

CASE 4.—C. E. CAMPBELL; private. Age 30. Extensive laceration of hand by cannon fire-cracker. Period of incubation, 11 days; general convulsions second day; treatment began second day; continued 16 days. Mulford's and N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxin admin-

istered daily, 10 c.c. q. 4 to 6 hours. Total amount injected, 1460 c.c. Subacute case. Recovery.

CASE 5.—G. W. GREEN; private. Boy. Compound fracture of humerus under dirty conditions. Period of incubation, 6 days; general convulsions first day; treatment began first day; continued 4 hours. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxin, 90 c.c. in divided doses. Total amount injected, 90 c.c. Very acute case. Death second day.

CASE 6.—H. E. PHELPS; private. Age 24. Slight cartridge wound of finger. Period of incubation, 8 days; general convulsions first day; treatment began first day; continued 3 days. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxin administered daily, 20–50 c.c. twice daily. Total amount injected, 170 c.c. Acute. Death on third day.

CASE 7.—F. R. CALKINS; private. Slight wound, palm of hand. Period of incubation, 5 days; general convulsions within 4 hours; treatment began second day; continued 1 injection. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxin, 20 c.c. 1 injection. Total amount injected, 20 c.c. Acute. Death on third day.

CASE 8.—HENRY FIELDS; private. Age 35. Compound Pott's fracture. Period of incubation, 10 days; trismus; general convulsions early; not severe; treatment began first day; continued 1 injection. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxin, 20 c.c. 1 injection. Total amount injected, 20 c.c. Acute. Death on third day.

CASE 9.—FRANK H. FLOOD; private. Age 12. Laceration of great toe by bicycle. Period of incubation, 9 days; sore throat; general convulsions within 4 hours; treatment began on second day; continued 1 injection. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxin, 50 c.c. at 1 injection. Total amount injected, 50 c.c. Acute. Death on second day, 3 hours after injection.

CASE 10.—L. S. MERRITT; private. Age 16. Toe crushed between cars. Period of incubation, 3 days; dysphagia; general convulsions within 12 hours; very severe; treatment began on third day; continued 1 injection. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxin, 30 c.c. at 1 injection. Total amount injected, 30 c.c. Acute. Death on third day.

CASE 11.—Period of incubation, 5 days; general convulsions 12 hours after onset; very severe; treatment began second day; continued 1 injection. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxin 500 c.c. at 1 injection. Total amount injected, 500 c.c. Acute. Death on second day.

CASE 12.—J. B. CONANT; private. Boy. Penetrating wound, left palm, by cartridge. Period of incubation, 10 days; general convulsions second day; treatment began second day; continued 2 days. Mulford's and P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxin administered daily, twice daily 10 c.c.–40 c.c. Total amount injected, 90 c.c. Death on eighth day.

CASE 13.—C. D. KLINE; private. Boy. Cartridge wound of hand with wad remaining in hand. Period of incubation, 8 days; general convulsions 8 hours after onset; very severe; treatment began on first day; continued 2 days. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxin administered daily, 20 c.c. once daily. Total amount injected, 40 c.c. Death on second day.

CASE 14.—W. W. TAYLOR; private. Age 65. Laceration of elbow in machinery. Period of incubation, 10 days; spasm of biceps of injured arm; general convulsions third day, not severe; treatment began fifth day; 1 injection. P. D. & Co.'s antitoxin used. Subcutaneous injection. Total amount injected, 30 c.c. Death on eighth day.

CASE 15.—M. B. DAVIS; private. Age 26. Crushed finger. Period of incubation, 8 days; stiff neck; general convulsions third day; severe on fourth day; treatment began on twelfth day; continued 6 days. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxin administered daily, each injection 30–50 c.c. Total amount injected, 300 c.c. Gradual recovery.

Case 16.—Private. Cartridge wound of hand. Period of incubation, 8 days; stiff neck and sore throat; general convulsions within 48 hours; treatment began on second day; continued 2 days. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxin administered daily, 10 c.c. q. 12 hours. Total amount injected, 80 c.c. Death on fourth day.

Case 17.—Alice M. Perrigo (head nurse), Mineola Hospital, Mineola, N. Y. End of finger crushed by hammer. Period of incubation, 10 days; possible convulsion on fifth day; treatment began on fifth day; continued 1 day. Mulford's antitoxin used. Subcutaneous injection of antitoxin administered daily, 4 injections, each 20 c.c. Total amount injected, 80 c.c. Death on sixth day.

Case 18.—Jas. H. McGan; private. Crushed foot. Period of incubation, 5 days; general convulsions 48 hours; severe. Mulford's antitoxin used. Death on fourth day.

Case 19.—Coryell Clark; private. Childbirth. Period of incubation, 6 days; general convulsions 36 hours; severe; treatment began second day; continued 3 days. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxin administered daily, 1 injection daily, 20 c.c.–80 c.c. Total amount injected, 170 c.c. Death on sixth day.

Case 20.—Geo. S. Skiff; private. Nail wound of foot. Period of incubation, 7 days; general convulsions third day; treatment began third day; continued 3 days. Subcutaneous injection of antitoxin, 400 units daily. Total amount injected, 2800 units. Death on seventh day. Antitoxin doubtful, possibly diphtheritic.

Case 21.—L. C. Green; private. Nail wound of foot. Period of incubation, 7 days; general convulsions second day; severe; treatment began second day; continued 1 day. Subcutaneous injection of antitoxin, 2 injections, 20 c.c. each. Total amount injected, 40 c.c. Death on fifth day.

Case 22.—C. I. Redfield; private. Age 6 months. Burn, second degree, on thumb. Period of incubation, 10 days; trismus; general convulsions ninth day; only a few; treatment began on fifth day; continued 4 days. Mulford's antitoxin used. Subcutaneous injection of antitoxin, 20 c.c. once daily. Total amount injected, 80 c.c. Death on ninth day.

Case 23.—Cassar Smith; private. Age 13. Lacerated wound, left knee. Malaise and trismus; general convulsions first day; treatment began first day; continued 2 days. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxin administered, 50 c.c. daily. Total amount injected, 100 c.c. Death on second day.

Case 24.—W. L. Clark; private. Age 39. Nail puncture of wrist. Period of incubation, 3 days; pain in back of neck, stiffness of neck, throat and jaw muscles; pain and contraction in wrist 2 days after injury; treatment began on first day; continued 3 days. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxin administered, 10 c.c. once daily. Total amount injected, 30 c.c. Recovery.

Case 25.—W. A. Leonard; private. Age 5½. Nail wound, left foot. Period of incubation, 7 days; sore throat, stiffness muscles of jaw, œsophagus and neck; general convulsions 48 hours; treatment began fourth day; continued 10 days. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxin 20 c.c. q. 4 hours. Total amount injected, 560 c.c. Recovery.

Case 26.—D. C. Moriata, Saratoga Hospital, Saratoga Springs. Age 45. Crushed shoulder by machinery at tannery. Period of incubation, 6 days; treatment began on second day; continued 2 days. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxin, 50 c.c. three times daily. Total amount injected, 300 c.c. Death on third day.

Case 27.—A. E. Ilett, Watertown City Hospital, Watertown, N. Y. Age 4. Compound fracture forearm. Period of incubation, 7 days; jerky muscles and opisthotonos; general convulsions 48 hours; treatment began on first day; continued 1 day. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection

of antitoxin, 3 injections 10 c.c. each. Total amount injected, 30 c.c. Death on second day.

CASE 28.—R. GERRAIS; private. Age 7. Wound of foot by broken glass. Period of incubation, 22 days; contracture of masseters; no general convulsions; treatment began on first day; continued 1 day. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxin, 50 c.c. 1 injection. Total amount injected, 50 c.c. Recovery. Prognosis would have been good without antitoxin.

CASE 29.—W. W. JAMIESON; private. Age 3 years, 10 months. Rusty nail-head perforated right side of head. Period of incubation, 4 days; treatment began on first day; continued 4 days. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxin, 15 c.c.–50 c.c. twice daily. Total amount injected, 265 c.c. Death on fourth day.

CASE 30.—H. M. REINHARDT; private. Age 23. Old nail injury to foot. Period of incubation, 8 days; some trismus, slight pain back of neck; general convulsions fifth day; treatment began on fifth day; continued 5 days. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxin, 90 c.c.–150 c.c. once daily. Total amount injected, 590 c.c. Recovery.

CASE 31.—ROBT. C. MEHNERT, German Hospital of Buffalo, N. Y. Age 16. Rusty nail wound right foot. History incomplete, admitted in convulsions; general convulsions probably quite frequent; chloroform used; continued 1 day. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxin, 2 injections 50 c.c. each. Total amount injected, 100 c.c. Death on following day.

CASE 32.—ADOLPH HOERR; private. Age 32. Nail wound, hand. Period of incubation, 6 days; marked local contraction of hand; general convulsions 39 hours after onset; treatment began on second day; continued 3 days. N. Y. S. D. of H.'s and P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxin, 40–90 c.c. twice daily. Total amount injected, 400 c.c. Death on fifth day. Apparently hypostatic pneumonia.

CASE 33.—G. E. WALKER; private. Age 10½. Sliver in knee removed with unclean pocket-knife. Period of incubation, 12 days; general convulsions second day; treatment began fourth day; continued 6 days. N. Y. S. D. of H.'s and P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxin 10 c.c. injected once or twice daily. Total amount injected, 100 c.c. Recovery. Case questionable.

CASE 34.—H. M. REINHARDT; private. Age 7. Lacerated wound sole of foot. Period of incubation, 14 days; general convulsions first day; treatment began on first day; continued 5 days. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxin, 50 c.c. twice daily. Total amount injected, 400 c.c. Recovery.

CASE 35.—A. R. WARNER, Cohoes City Hospital, Cohoes, N. Y. Age 15. Cartridge wound base of fingers. Period of incubation, 8 days; treatment began first day; continued 2 days. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxin, 50 c.c.–100 c.c. daily. Total amount injected, 150 c.c. Death on second day.

CASE 36.—JOHN NUGENT; private. Age 60. Nail puncture left foot. Period of incubation, 9 days; general convulsions very mild on third day; treatment began on second day; continued 2 days. N. Y. S. D. of H.'s and Mulford's antitoxin used. Subcutaneous injection of antitoxin, 40 c.c.–60 c.c. daily. Total amount injected, 100 c.c. Death on third day.

CASE 37.—CHAS. C. SWEET, Samaritan Hospital, Troy, N. Y. Age 28. Crushed right hand in corn husker. Period of incubation, 12 days; no general convulsions; treatment began on second day; continued 6 days. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxin, 50 c.c. q. 6 hours. Total amount injected, 900 c.c. Recovery. Serum used locally.

CASE 38.—A. F. WRIGHT; private. Age 11. Abrasion on toe. Period of incubation, 13 days; general convulsions on sixth day; continued sixteenth

day. N. Y. S. D. of H.'s and P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxin, 10 c.c.–40 c.c. for 5 injections. Total amount injected, 80 c.c. Recovery.

CASE 39.—F. E. LEWIS; private. Age 12. Clean cut on hand. Period of incubation 11 to 12 days; general convulsions; date questionable; treatment began on sixth or seventh day; continued 2 days. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxin, 20 c.c. for 3 injections. Total amount injected, 60 c.c. Death on eighth or ninth day.

CASE 40.—CHAS. C. SWEET, Samaritan Hospital, Troy, N. Y. Age 28. Crushed right hand in corn husker. Period of incubation, 12 days; trismus and dysphagia; no general convulsions; treatment began on second day; continued 6 days. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxin administered daily, 50 c.c. q. 6 hours. Total amount injected, 950 c.c. Gradual recovery.

CASE 41.—W. J. CARR; private. Age 34. Nail wound of foot. Period of incubation, 5 days; trismus; general convulsions on third day; treatment began on third day; continued 1 day. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxin, 1 injection 50 c.c. Total amount injected, 50 c.c. Death on fourth day.

CASE 42.—H. W. SCHLAFFI, German Hospital, Buffalo, N. Y. Age 16. Contusion and laceration of leg. Period of incubation, 12 days; treatment began second day; continued 4 days. Subcutaneous injection of antitoxin, 50 c.c. daily subcutaneously; 50 c.c. daily deep into muscle. Total amount injected, 400 c.c. Death on fifth day.

CASES OF TETANUS TREATED BY INJECTION INTO VARIOUS STRUCTURES, OF ANTITOXIN MADE AND FURNISHED BY THE NEW YORK STATE DEPARTMENT OF HEALTH.

CASE 1.—A. W. ELTING; private. Age 35. Abortion. Period of incubation, 8 days; trismus; general convulsions seventh day; treatment began on eleventh day; continued 6 days. P. D. & Co.'s, Behring and N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxic serum, eleventh to fourteenth days q. 6 hours = 10 c.c.; fourteenth to eighteenth days 8 injections; total, 1050 c.c. Intraspinal injection, subdural, 150 c.c. Total amount injected, 1200 c.c. Some sleep and rest after some of the injections. Subacute case, slow recovery.

CASE 2.—A. W. ELTING; private. Age 57. Nail wound of foot. Period of incubation, 10 days; pain and stiffness of jaws and neck; general convulsions third day; treatment began on second day; continued 3 days. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxic serum, 450 c.c. = 6 injections. Intraspinal injection, lumbar puncture, 3 injections, 50 c.c. each. Total amount injected, 600 c.c. Improvement following use of antitoxin. Death in spasm on fifth day from arterio-sclerosis. Tetanus was not progressing.

CASE 3.—A. W. ELTING; private. Age 14. Nail wound of foot. Period of incubation, 7 days; trismus—marked local contraction injured leg third day; general convulsions third day; treatment began on second day; continued 2 days. N. Y. S. D. of H.'s and P. D. & Co.'s antitoxin used. Subcutaneous injection of antitoxic serum, 6 injections = 270 c.c., 20 c.c.-50 c.c. Intraspinal injection, 50 c.c., 1 injection. Total amount injected, 320 c.c. Some relief from subdural injection; none from subcutaneous. Death on fourth day.

CASE 4.—C. H. TRAVELL; private. Age 27. Punctured wound of foot. Period of incubation, 7 days; stiffness muscles face and jaw; general convulsions third day; treatment began on sixth day; continued 4 days. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxic serum, 6 injections = 270 c.c. Intraspinal injection, 2 injections, 80 c.c. Total amount injected, 350 c.c. Marked improvement from subdural injection, subcutaneous no effect. Recovery.

CASE 5.—SHELDON VORHEES; private. Age 53. Burns, third degree, legs. Period of incubation, 17 days; trismus; treatment began first day; continued 8 days. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxic serum, 12 injections = 10 c.c.–100 c.c. each. Intraspinal injection, 1 injection 100 c.c. Total amount injected, 840 c.c. Chronic case; poor general condition. Death on eighth day.

CASE 6.—W. J. CARR; private. Age 55. Traumatic amputation of toes by threshing machine. Period of incubation, 7 days; dysphagia and trismus; general convulsions fourth day; treatment began first day; continued 2 days. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxic serum, 5 c.c. twice. Intravenous injection, 100 c.c. Total amount injected, 110 c.c. Death on third day.

CASE 7.—R. M. VOSE; private. Age 45. Punctured wound of foot; nail, Period of incubation, 10 days; general convulsions 28 hours after onset; treatment began on second day; continued 2 days. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxic serum, 2 injections, 20 c.c. and 30 c.c. Intraspinal injection, 1 injection 30 c.c. Total amount injected, 80 c.c. Death in 65 hours.

CASE 8.—F. J. PARMENTER and ROSWELL PARK; private. Age 9. Tack wound of foot. Period of incubation, 7 days; stiffness in neck; general convulsions third day; treatment began on second day; continued 1 day. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxic serum, 1 injection. Intraneural injection, 30 c.c. Intraspinal injection, 1 injection. Total amount injected, 80 c.c. Death on third day.

CASE 9.—A. VANDERVEER; private. Age 8. Compound fracture of forearm, penetration of bone into dirt of lawn. Period of incubation, 5 days; pain in injured arm and trismus; treatment began on first day; continued 1 day. Subcutaneous injection of antitoxic serum, 50 c.c.–100 c.c. Intraspinal injection, 50 c.c. Total amount injected, 200 c.c. Death on second day.

CASE 10.—A. VANDERVEER, Albany City Hospital, Albany, N. Y. Age 6. Cartridge wound right hand. Period of incubation, 7 days; trismus; general convulsions; under chloroform most of time; treatment began second day; continued 1 day. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxic serum, 50 c.c. Intraspinal injection, 30 c.c. Total amount injected, 80 c.c. Death on second day.

CASE 11.—MARSHALL CLINTON; private. Age 24. Compound comminuted fracture right femur. Period of incubation, 5 days; general convulsions first day; treatment began on first day; continued 1 day. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxic serum, 40 c.c.–50 c.c. Intraspinal injection, 10 c.c. Total amount injected, 100 c.c. Death on third day.

CASE 12.—A. GILBERT; private. Age 20–22. Thrown from train, long wound right calf. Period of incubation, 6 days; general convulsions first day; treatment began first day; continued 3 days. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxic serum, 50 c.c.–100 c.c.–100 c.c. Intraspinal injection, 7 c.c. of 25 per cent. $MgSO_4$ solution. Total amount injected, 250 c.c. +. Death on third day.

CASE 13.—JOHN W. RILEY; private. Age 26. Crack in left thumb. Period of incubation, 11 days; spasm of masseters and neck muscles; general convulsions second day; treatment began first day; continued 2 days. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxic serum, 30 c.c., 50 c.c., 70 c.c., 50 c.c. Intraspinal injection, 50 c.c. Total amount injected, 250 c.c. Death on second day.

CASE 14.—MARSHALL CLINTON; private. Age 14. Wound of foot with pitchfork. Period of incubation, 12 days; stiffness of jaw and neck; general convulsions second day; treatment began second day; continued 2 days. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxic serum, 14 injections, 50 c.c. each. Intraneural injection, 5 c.c. Intraspinal injection, 5 c.c., 6 c.c. Total amount injected, 716 c.c. Recovery.

CASE 15.—R. O. CROISER; private. Age 38. Punctured wound of foot. Period of incubation, 6 days; stiffness of jaw and neck; general convulsions second day; treatment began first day; continued 2 days. N. Y. S. D. of H.'s antitoxin used. Subcutaneous injection of antitoxic serum, 4 injections, 10 c.c. each. Intraneural injection, 10 c.c. Total amount injected, 50 c.c. Death on third day.

CASE 16.—W. J. CARR; private. Age 10. Pistol shot wound index finger. Period of incubation, 5 days; general convulsions first day; treatment began on first day; continued 1 day. N. Y. S. D. of H.'s antitoxin used. Intraneural injection, 8 c.c. Intravenous injection, 40 c.c. Total amount injected, 48 c.c. Death on second day.

CASE OF TETANUS TREATED BY INTRACEREBRAL INJECTION OF ANTITOXIN MADE AND FURNISHED BY THE NEW YORK STATE DEPARTMENT OF HEALTH.

CASE 1.—H. W. NASH; private. Boy. Cartridge wound of hand. Period of incubation, 7 days; general convulsions 7 hours, very severe; treatment began second day; continued, 2 injections. N. Y. S. D. of H.'s antitoxin used. Intracerebral injection of antitoxin administered daily, 2 injections 5 c.c. each. Total amount injected, 10 c.c. Death in convulsion, second day.

THE TREATMENT OF TETANUS BY MAGNESIUM SULPHATE.

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The treatment of tetanus by magnesium sulphate was suggested by the discovery, by Dr. S. J. Meltzer, of the marked action of this salt, when applied to nerve tissues, in inhibiting both afferent and efferent impulses.

Although similar effects can be produced by subcutaneous or intravenous injections, they are accompanied by symptoms due to the depressing effect of the drug upon the higher centres, both in the medulla and cerebrum. The action on the medulla produces slowing of respiration and finally death by paralysis of the respiratory centre.

In lumbar injections into the subdural space the drug acts directly upon the nerve trunks at the site of injection, as is evidenced by paralysis of motion and sensation in the lower extremities, and as it diffuses itself upward along the cord the paralysis extends to the trunk and upper extremities, diminishing, however, in intensity as it progresses.

Absorption of magnesium sulphate from the spinal canal is fairly slow, and definite action upon the nerve trunks may be obtained, while the general effects upon the higher centres may not manifest themselves for several hours or may be wholly absent. In fact, Meltzer has found that the magnesium sulphate may be removed from the spinal canal by lumbar puncture and washing, after the desired local effects have been obtained, and the undesirable action upon the higher centres wholly prevented or stopped

if already commenced. On the other hand, it has been demonstrated by Dr. Teague, in experiments carried out in the Surgical Research Laboratory of Columbia University, that the drug is to a certain extent cumulative in its action. For instance, a dose insufficient in itself to produce symptoms, when injected into the peritoneal cavity of guinea-pigs, will produce death when repeated at the end of twenty-four hours. In the treatment of tetanus the dose is ordinarily repeated and this fact should be borne in mind.

Meltzer found that one cubic centimeter of a 25 per cent. solution of magnesium sulphate to every twenty-five pounds body-weight was sufficient, when injected into the spinal canal, to produce, in most cases, anæsthesia to the surgical degree from the neck down. As reported in a former paper, I have found a marked variation in the effects of the drug. For instance, a similar amount per pound of body weight produced no anesthesia and very slight motor paralysis in one patient, while in another its action was most profound, producing unconsciousness which lasted nineteen hours, and paralysis of motion and sensation persisting for over forty-five hours. Age and sex seem to have a direct bearing upon its action, and in the same paper I made the following statement: "As far as can be learned from our present experience, children are quite susceptible, and women more so than men. The dose for a child should probably never exceed one cubic centimeter for every twenty-five pounds' body weight, the dose for a woman should not be less, while the dose for a male adult should be probably not less than a cubic centimeter for every twenty pounds." In the treatment of tetanus, the dose usually has to be repeated and consequently may be corrected, so the uncertainty in regard to its effect is not so important as it otherwise might be. While uncertainty as to its effects might contraindicate its use for the less dangerous conditions, tetanus is attended by such a great mortality that we are justified in using anything that promises to be beneficial.

It is unfortunate that we are unable to derive much information from experimental work with animals since the anatomical pecu-

liarities preclude intraspinal injections except in monkeys. Dr. Teague has found that intraperitoneal injections in guinea-pigs produce little or no effect on the convulsions in induced tetanus unless a lethal dose is given. For instance, if a local tetanic spasm of a limb is induced by the injection of tetanus toxin, it cannot be controlled by an intraperitoneal injection of magnesium sulphate unless in excessive doses.

From our experience in human tetanus, we know that intraspinal injections relieve spasm, so we must infer that it produces a block of nerve impulses by direct action on the nerve trunks. So far, its employment in human tetanus has not been attended by uniform results. This fact may be due to different degrees of susceptibility on the part of the patient and partly by variations in technique or lack of experience, in the use of magnesium sulphate, on the part of the medical attendant. As far as I can ascertain, only four cases of tetanus have been treated with magnesium sulphate.

The first was treated by myself at the Roosevelt Hospital, and this, together with a case treated by Dr. F. H. Markoe at the New York Hospital, are reported in full by me in the *Journal of Surgery, Gynecology and Obstetrics* for May, 1906. Since then, the report of two other cases, by Dr. Samuel Logan, of New Orleans, has appeared in the *Journal of the American Medical Association*, May 19, 1906. In addition to these four cases of tetanus a case of general miliary tuberculosis, with symptoms closely resembling those of tetanus, has been treated by me and is interesting in demonstrating the effect of the drug upon the convulsions.

Of these patients only one has recovered, namely, the first patient treated by myself.

A detailed report of these cases in the present paper would require too much time and I consequently limit myself to a statement of my deductions derived from the study of them.

In my patient, a case of acute tetanus in a boy, fifteen years of age, starting in a wound of the hand, we were either very fortunate in hitting upon the correct dose or else the patient was

peculiarly susceptible to the action of the drug. There is not the slightest doubt in my own or in the minds of those who observed the patient, that the drug had a very marked effect in inhibiting the convulsive seizures, relieving pain and producing rest. For instance, the patient at the beginning of the treatment was in a condition of practically constant opisthotonos, with rigid scaphoid abdomen and well marked trismus. Rest and nutrition were impossible. The effect of magnesium sulphate was to produce complete relaxation of the muscles of the trunk and the extremities and considerable relaxation of the muscles of the jaw, so much so, that the patient rested quietly and could swallow easily.

The injections controlled the convulsions in this patient for periods varying from twenty-nine to thirty-seven hours each. The latter parts of these periods the convulsions would begin to return and gradually increase in severity until they reached a point when it was deemed wise to give another injection. No injurious effects were noted in this patient except that throughout the treatment there was, as might be expected, paralysis of the bladder. The dose was the same as recommended by Dr. Meltzer for the production of anesthesia.

At the time the injections of magnesium sulphate were stopped, the patient was running along with the symptoms we would expect in an ordinary case of chronic tetanus. At one time, six days after the last injection of magnesium sulphate, the convulsions became more severe and magnesium sulphate was given again with similar effect.

Before commencing treatment with magnesium sulphate in this patient, he was given several injections of tetanus antitoxin, one of them into the cervical cord, with no apparent effect. My impressions from observing this patient were, that with the aid of magnesium sulphate we were able to keep up nourishment and strength so that his vital forces could control the disease and that in reaching this control the injected antitoxin was probably a great aid.

According to Norris, death in tetanus may ocur in a convulsion and be due to asphyxia or spasm of the heart, or on the other hand,

in about half the cases, it is due to exhaustion. Exhaustion may be caused by excessive convulsions and by lack of nourishment. In such cases, judging by our experience in the case just reported, magnesium sulphate will be a great help. There are, however, a certain number of cases of tetanus which die in the first few days of the disease and which die in a condition of asthenia which can hardly be attributed to exhaustion from convulsions or from lack of nourishment. In these cases, death seems to be due to a depressing action of the toxins and magnesium sulphate would probably be of no benefit. Dr. Markoe's case is an example of this class. In his case, a moderate dose of magnesium sulphate was given fifteen hours after the initial symptoms of the disease with only a slight effect upon the convulsions, the patient dying thirteen hours later, the entire illness lasting twenty-eight hours. There were no symptoms referable to an overdose of magnesium sulphate.

In Case 1, reported by Dr. Logan, death occurred at the end of the fourth day of the disease with symptoms of heart failure and hyperpyrexia. Two injections of magnesium sulphate were given. The first, about forty-one hours before death, produced complete relaxation even of the jaws and relieved the pain completely for over twelve hours. The tonic spasm then returned rapidly in the trunk and extremities. Eighteen hours after the injection, the general spasm was marked and there was twitching on attempting to swallow. The second injection was given twenty-four hours after the first, and again produced complete relaxation which lasted until his death, sixteen hours later, with the exception of a general convulsion induced by giving an enema two hours after the last injection of magnesium sulphate.

This patient's condition, although somewhat improved by the first injection, grew progressively worse after the second. There was excessive bronchorrhea, the respirations were rapid and shallow, the heart's action feeble. The respiration was not slowed, as is usually the case with large doses of magnesium sulphate.

An analysis of the treatment in this case is noteworthy. The

patient was a boy eleven years of age, the bodyweight was estimated at eighty pounds. On the first day of the disease he was given fifty cubic centimeters of antitetanic serum by lumbar puncture. In the thirty-six hours preceding the injection of magnesium sulphate, he had received 170 grains of chloral and 450 grains of bromide, without effect upon the convulsions. Both injections of magnesium sulphate were given under general anesthesia. Fifty cubic centimeters of antitetanic serum were given at the same time with the first injection. The duration of the first anæsthesia was forty minutes, of the second thirty-five. Possibly the large doses of chloral may have depressed the heart's action and that, together with the ether, may have caused the bronchorrhea.

It is not necessary to give an anæsthetic to perform lumbar puncture, and one of the advantages of magnesium sulphate is that it produces sufficient anesthesia for redressment of the wound. The dose of magnesium sulphate was large, one cubic centimeter of the 25 per cent. solution for every twenty pounds at the first dose, and one cubic centimeter for every twenty-four pounds' body weight at the second dose. Possibly its action may have been cumulative, inasmuch as the dose was repeated in twenty-four hours. The action of the second dose was certainly very profound.

In the second case reported by Dr. Logan there was absolutely no result from the use of magnesium sulphate. The patient was a woman twenty-four years of age, and received a dosage corresponding to one cubic centimeter for every twenty-five pounds' body weight. The first injection producing no result, it was followed seventeen hours later by another, the patient dying of failure of respiration in a tetanic seizure a short time afterward.

Although this last was a severe case there should have been some result and the failure of the magnesium sulphate is apparently another instance of the unreliability that has been demonstrated in its use for producing anæsthesia.

In the case of general miliary tuberculosis resembling tetanus, already mentioned, magnesium sulphate was quite efficient in

controlling the convulsions and was repeated nine times in eight days, once with an interval of only thirteen hours, without producing untoward symptoms.

My impression of the drug is, that although we cannot be certain of its effect, yet it is reasonably safe and offers us a means of modifying the convulsions and relieving pain in a way no other drug has approached. For these reasons alone it is worthy of a more extended trial.

It is not a specific treatment, but it produces anesthesia which may be taken advantage of for intraneural or other injections of tetanus antitoxin and for re-dressing the site of the infection.

PRACTICAL BACTERIOLOGICAL STUDIES IN THE SURGICAL CLINIC.

By WILLIS G. MacDONALD, M.D.,
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STANDARDS of aseptic technique vary in clinics from the most primitive to most elaborate and involved systems. The ultimate results attained are often identical under both conditions. No standard, however great its merits, will be maintained without constant attention to the minutest detail. In clinics where the personnel is permanent, where few changes occur in the operating room, a system may be maintained with comparative ease. This is especially true when the surgeons, the assistants and nurses have healthy enthusiasm and friendly co-operation in their work. On the other hand, the problem becomes difficult in other large clinics associated with teaching hospitals, having training schools for nurses and resident physicians who serve only for a brief period. All the nurses in training are employed for a term in the operating room and participate in operations and the internes are early at the operating table. Many of them are absolutely unfitted for the work both by temperament and education. Under such conditions the most painstaking supervision is required.

Experience demonstrates beyond contradiction that surgical asepsis cannot be taught by didactic lecture; it can only be learned by practical experience in which the sources of infection are made real and tangible. The routine employment of bacteriological studies in the surgical clinics becomes indispensable where a high degree of efficiency is technically maintained. Bacteria to be appreciated by interne and nurse must be seen.

In every hospital occasional and unexpected sepsis occurs at greater or less intervals, a condition that should be met by a frank, fair and immediate investigation to fix the source and establish responsibility.

If in any division of a hospital wounds do not heal without sepsis, the trouble can be usually traced to inefficient skin preparation by the nurse in charge, or to a negligent resident surgeon. An unannounced visit for the purpose of taking cultures from all the wounds, dressing and accessories, from the hands of the nurses and resident surgeon acting as dresser, will go far to remedy the difficulty. If after a few days all the cultures taken are demonstrated in the ward and present a single bacterian as a common source of all the infections, and that the organism is on the hands of both resident and nurse, much will have been accomplished. Subsequent cases for operation coming from the infected wards should have small portions of the skin excised from the border of the freshly made wound, the antiseptics neutralized and the whole portion placed in a large culture of nutrient bouillon as a test. A little farther attention to the care of utensils in preparing patients for operation and at dressings will add to the completeness. A recent experience occurred in a single pavilion of a large hospital. There was no dangerous *infection* or *marked constitutional reaction* in any case. Superficial *suppuration in the wound,* latent indurations and late infections, two weeks after operation, were the usual manifestations. In the other divisions of the hospital healing was most satisfactory.

Ordinary criticism and remonstrance was not followed by improved conditions. On the contrary, the nurse in charge and the resident surgeon were both confident that infections came from catgut. Bouillon cultures were taken, generally without notice, from wounds, prepared hands, dressing and utensils, and placed in a thermostat after thirty-six hours and afterward plated. The dressings were uniformly sterile. Nearly all the wounds and hands were contaminated either by a single, constant or multiple variety of bacterian. A micrococcus identified as the streptococcus pyogenes aureus was constant.

Its original source was traced to a patient suffering from a rather chronic inflammatory process treated by hot fomentations and by frequent dressings. In order to fully satisfy the requirements of the situation nearly a hundred cultures were taken, including transfers to solid media, a considerable labor. The results attained, however, were commensurate. Every nurse and interne knew a streptococcus as a living and dangerous entity—having size, form, arrangement and cultural individuality—a menace to asepsis real and tangible. Farther, there was more isolation of infected cases, there was more exactness in the preparation of patients, and the resident surgeon knew more of the philosophy of rubber gloves than ever before. The personnel of that surgical division were made to feel that they were distinctively on trial. The ultimate result was the total absence of preventable sepsis in that division for a period, but it awaits a recurrent storm unless laboratory methods are re-employed at irregular intervals and without notice.

Another condition occurred in a large hospital of modern construction, with operating rooms of the most approved aseptic architecture, where a conflict of opinion occurred as to who was to clean the walls and furniture, whether *the nursing* or *the domestic department* was to do the work. The natural consequences followed, the rooms were not cleaned or sterilized at sufficiently regular intervals. A board of governors with little knowledge says: "That the air is not a source of contagion,"—they had heard it in a surgery stated that it was a notion of Lister's exploded long ago, that patients do not ordinarily come in contact with the floor and walls of operating rooms. They failed to provide for necessary cleaning until over two hundred cultures were taken demonstrating the air as a source of infection through suspended matter. As a fair test Petri dishes, fifteen centimeters in diameter, containing nutrient agar with glycerine, were exposed for twenty minutes in various parts of the general amphitheatre during the beginning of a surgical clinic. Each plate demonstrated from forty-three to ninety-four colonies, and in each plate the staphylococcus pyogenes aureus was demonstrated. A repetition of the

experiment under identical conditions a day later after a thorough domestic cleaning showed an average reduction to thirty colonies per plate, with practically no pathogenic organisms, chiefly air bacteria and moulds. Remaining conditions were practically identical in all of the smaller operating rooms. The results of these preliminary examinations led, through the demonstration of the culture, to a satisfactory arrangement in the domestic cleaning of the operating rooms. The writer yet feels that his crusade for frequent cleaning with water and soap has not added materially to his popularity with the constituted authorities of the institution.

A source of infection too frequently not considered is the fine spray of infective saliva expelled from the mouth during conversation. Miller demonstrated over eighty varieties of microorganisms found in the mouth under ordinary conditions, many of which are pathogenic. The usual pathogenic varieties are commonly found. Mendes de Leon (*Ueber die Gefahren der Mundinfection durch das Sphrechen bei Operationen*) took stenographic notes of the conversation of operators and assistants during different operations and afterward counted the words spoken; they varied from 110 to 354 words, many of which were expletives and unnecessary descriptions of the operation. The operations required from twenty to forty-five minutes and presented no unusual features.

Huebner, in his experiments in the von Mikulicz clinic, placed agar plates the size of the usual field of operation fifty centimeters from the face, the usual distance of an operator's face from the wound. After speaking at intervals for ten minutes, about 200 words, toward the plates, under ordinary conditions of voice and without a mask, the colonies were developed. The results varied from 436 to 581 separate and distinct colonies. The writer has conducted on a purely practical basis a considerable group of similar experiments the technique being as follows:

A Petri dish, fifteen centimetres in diameter, containing glycerin-agar, is placed the ordinary working distance from the surgeon's lips. The words ordinarily required during a typical

operation are spoken toward the plate, after which it is placed in a thermostat and the colonies developed and counted.

GROUP I. *Sixteen Cultures.* The results among four persons speaking without masks were as follows: Dr. M. (the writer) five trials, most 431 colonies, least 268 colonies, average 348 colonies. Dr. G. five trials, most 458 colonies, least 241 colonies, average 327 colonies. Nurse J. (who spoke very low with closed lips and was rebellious to the experiment because she disliked wearing a mask during operations) three trials, most 157 colonies, least 95, average 117. Nurse S., who acted fairly, three trials, most 386 colonies, least 295, average 331 colonies.

GROUP II. Same conditions, only masks covered with four layers of aseptic gauze were worn. Dr. M. five trials, most 68 colonies, least 46, average 54; staphylococcus pyogenes aureus found twice. Dr. G. five trials, most 52 colonies, least 31, average 43 colonies. Nurse L. three trials, most 41 colonies, least 11, average 22 colonies. Nurse S. three trials, most 49 colonies, least 17, average 31 colonies.

GROUP III. Same conditions as group II, except that mouth was washed and teeth cleaned with a solution of boric acid; did not show any material improvement in the average number of colonies.

GROUP IV. Same as Group II, except that masks covered with eight thicknesses, of sterilized aseptic gauze were used, and the total average number of colonies were reduced to seven, one-fourth of the plates remaining sterile after exposure.

One can readily imagine the conditions involved in a demonstration operation, where the unmasked operator lectures as he operates to a crowded clinic and is surrounded by assistants and visitors. It is no wonder that disturbed wound-healing occurs, with leukocytes and so-called surgical fever occasionally. An active phagocytosis and a physiologic immunity are important factors in securing asepsis, elements that cannot be definitely measured as yet under the individual conditions of practical surgery or in the experiment laboratory.

The preparation and duty room in the operating pavilion

require frequent bacteriological provings. Brushes and rubber gloves prepared for operation are not always sterile. The duty of their preparation is detailed to a nurse in training, under supervision to be sure, and with specific direction; but diffident powers of observation, lack of absolute knowledge, or the absence of personal integrity may lead to insufficient preparation and infected gloves and brushes. The irregular but constant taking of cultures, with judicious praise of the work when the cultures are found sterile, and the demonstration, publicity and wholesome criticism of infection and the establishment of personal responsibility in the nursing force are the only practical safeguard.

Trusting that a brief digression may be allowed for the discussion of sterile catgut, the writer wishes to state that no known method employed will uniformly be satisfactory even in the most painstaking hands. This statement is especially true with relation to chromicized catgut. Catgut placed upon the market by our best firms is occasionally infected, especially the large sizes. This is no matter of opinion but of actual laboratory experiment, with unquestionable demonstration. Every quantity of catgut prepared should be tested by special methods bacteriologically before using in wounds. The cumol and a modified Claudius methods have been most employed. By exact method of preparations sizes up to No. 3 are reasonably safe. Absorption, however, occurs too early to make these sizes of catgut safe in hernia and abdominal-section wounds.

Visitors to operations, either the attending physician of the patient or visiting physicians or students, are a constant menace to surgical asepsis, even though their clothing is covered by sterile gowns. In their anxiety to see the details of the operation, they crowd upon the field of operation, ask questions, cough near the instrument table, and bring large quantities of macroscopic dirt on their shoes to the operating-room. Air cultures taken at all my operations for a period of three months, over 150 experiments, showed that the number of spectators influenced the numbers of colonies which developed on the agar plates. The ratio of colonies to visitors was reasonably consistent. Keeping the

operating-room floors well sprinkled with plain water reduced the number of colonies about one-third. The results were, however, not sufficiently uniform to be authoritative.

The ultimate conclusions of this continued study followed along many other lines in bacteriology in the clinic are definite and valuable although not new.

First, the distinctive necessity of constant cultural work, in order that the personnel of the clinic be made alert and to feel a *personal responsibility*.

Second, to establish consistent daily detail work, both in the wards and in the operating-room without constant criticism.

Third, to be able to trace to its source occasional infection and remedy it before serious damage occurs.

Fourth, to establish the inefficiency of many plans recommended in medical literature which are essentially fallacious; for example, the four-fold gauze mask.

There remains another and equally important function of surgical bacteriology, the discussion of which is forbidden by the limitations of time, namely, its purely clinical and diagnostic value in tuberculosis, tetanus, actinomyces and other infectious processes.

FURTHER OBSERVATIONS ON THE ANATOMY OF THE DUODENUM.

By A. J. OCHSNER M.D.
CHICAGO.

One year ago I directed attention to an anatomical condition of the duodenum, which consists in a marked thickening of the circular muscle fibres of this portion of the alimentary canal at a point below the entrance of the common duct. This was proved by a large number of dissections.

A considerable variation was found in the exact position of these muscle fibres. In some instances they were arranged in a narrow circular band forming a distinct sphincter; in other instances the thickening was diffused, making a broad circular band; and in a few instances the thickening was in two different bands, with an intervening portion in which the circular muscle fibres were of the same thickness as the remaining portion of the duodenum.

There was a further difference in the location of this duodenal sphincter; in most specimens it was located from 3 to 10 cm. below the point of entrance of the common duct, while in a few instances a portion of the sphincter included a point of entrance of the common duct, the remaining portion, however, being always located below this point.

This arrangement of circular muscle fibres was shown by a number of drawings made of the exact size of specimens when they were taken from the cadavers.

These conditions seem to explain a number of physiological facts: the fact that vomiting when the stomach is relatively empty always expels a certain amount of bile; and the fact that in many cases in

which there is a dilatation of the stomach without constriction of the pylorus, with an ulcer in the pyloric end, the ulcer frequently extends into the duodenum. It may also explain some of the stomach symptoms which are so constantly observed in connection with gallstone disease. It will also explain a condition not infrequently encountered in operating for the relief of gallstones and ulcer of the stomach, that is, the presence of a greatly distended duodenum, with a completely contracted first portion of the jejunum.

It also explains the presence of the bile-staining of the portion of the duodenum above the common duct in the cadaver, while the portion below this point is usually free. This condition has been noted by many observers.

It has seemed to me as though this arrangement of circular muscle fibres serves the purpose of a sphincter to facilitate the process of mixing the bile and the pancreatic juice in the duodenum, which has been so perfectly described by Dr. Walter B. Cannon.[1]

The presence of a gastric ulcer in a considerable proportion of patients that have suffered from chronic appendicitis may have some relation to this condition in the following manner: there is undoubtedly an obstruction of the ileocæcal valve, due to the physiological contraction of this sphincter during an acute exacerbation of appendicitis, for the purpose of establishing a condition of rest in this vicinity. This is followed by nausea and vomiting, and it seems reasonable to suppose that the ileocæcal valve initiates return peristalsis and that this in turn excites a contraction of the duodenal sphincter and the pyloric sphincter, and that in this way a normal passage of food from the stomach into the intestines is interfered with, causing an accumulation of residual food in the stomach, and that the irritation caused in this manner may be an etiological factor in the production of gastric ulcer. It may also explain the presence of bile in the vomitus of patients suffering from intestinal obstruction.

During the past year Dr. John T. Finney[2] and Dr. William J.

[1] Annals of Surgery, May, 1905.

[2] Dilatation of the Duodenum, Boston Medical and Surgical Journal.

Mayo[1] have referred to this condition in their writings, and I have added a few cases to my list published one year ago, which I will report in this paper.

Since the publication of my last paper, my assistant, Dr. E. W. Thuerer, has carefully examined the duodenum of twenty-nine cadavers in the dissecting-room of the Medical Department of the

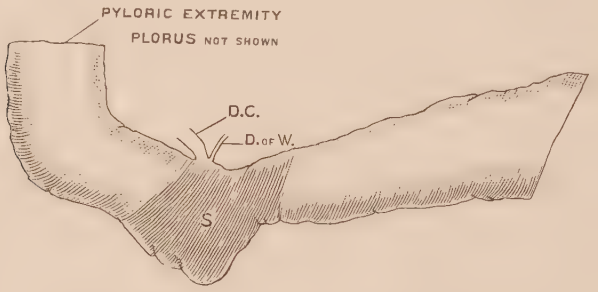

FIG. 1.—Specimen showing a single sphincter beginning at a point even with the upper margin of the entrance of the common bile duct and extending downward 3 cm.: D. C., common duct; D. of W., duct of Wirsung; S., sphincter.

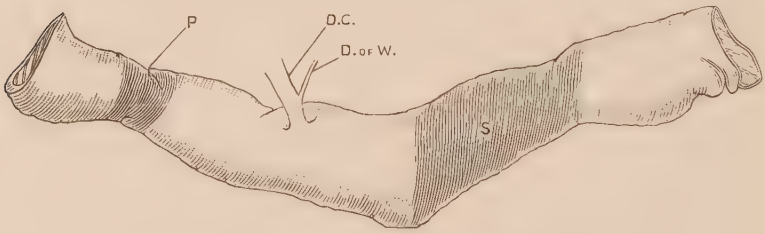

FIG. 2.—Specimen showing a broad sphincter 4 cm. below the entrance of the common bile duct: D. C., common duct; D. of W., duct of Wirsung; S., sphincter; P., pylorus.

University of Illinois, and has confirmed the observations made last year. He has made full-sized drawings of twelve duodeni of all the varieties in arrangement of muscle fibres that he has encountered during this year—choosing the most typical specimens of the entire number examined.

[1] Jour. Amer. Med. Assoc., October 12, 1905.

I reproduce herewith eight of these drawings (Figs. 1 to 8), each with its accompanying description. It seems to me that a study of the arrangement of circular muscle fibres of the duodenum is of sufficient importance to demand some attention. In the meantime, we have made a study of other anatomical facts connected with this intestine, but confine this report to this one feature especially, because it seems to have been almost completely neglected in the studies which have been made of this portion of the alimentary canal.

We have made a series of observations in a number of the lower animals, including the cat, dog, pig, guinea-pig, rat, chicken, and pigeon, which seems to point toward some interesting anatomical facts connected with the duodenum of the herbivorous and carnivorous animals. It will, however, require a much larger number of observations than have been made at the present time to warrant definite conclusions. We will consequently defer a consideration of this portion of the subject until some future time.

I append a synoptical statement of the case histories of sixteen patients operated upon during the last year, in whom there was dilatation of the upper portion of the duodenum.

Case XV.—Female, aged forty-eight years. *Symptoms:* pain in epigastrium, radiating to the back; slight tenderness in the epigastrium. Was operated upon for gallstones and appendicitis four years previously. *Diagnosis:* gastric ulcer; cholecystitis. *Operation*, May 26, 1905: pylorectomy; cholecystostomy. The pylorus was adherent to the omentum, and the omentum to the anterior abdominal wall; there was a scar of an old ulcer on the posterior wall of the stomach; the duodenum was dilated, and the jejunum contracted.

Case XVI.—Female, aged sixty years. *Symptoms:* constipation and diarrhœa; excessive abdominal distention. *Diagnosis:* cholecystitis; intestinal obstruction. The patient had also multiple cysts of the left kidney. *Operation,* August 4, 1905: cholecystostomy. The peritoneal cavity contained free bile; there were bands of adhesions between the omentum and the large bowel; the duodenum was enormously distended.

CASE XVII.—Female, aged twenty-nine years. *Symptoms:* burning pain in the epigastrium; frequent vomiting; palpitation of the heart; tenderness in the upper epigastrium. *Diagnosis:* gastric ulcer; appendicitis. *Operation*, August 24, 1905: appendectomy. The point of the appendix was adherent to the uterus,

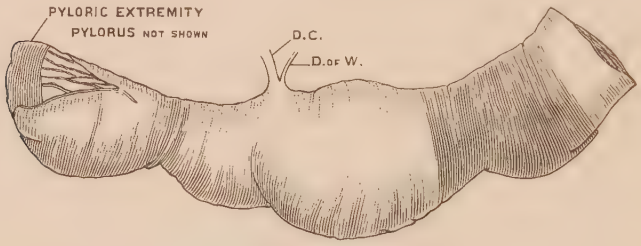

FIG. 3.—Specimen showing a broad sphincter 4 cm. below the entrance of the common bile duct, with marked dilatation of the duodenum above this point: D. C., common duct; D. of W., duct of Wirsung.

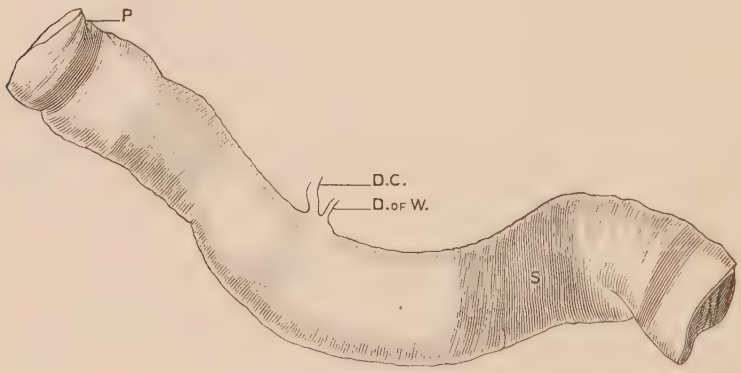

FIG. 4.—Specimen showing a broad sphincter 5 cm. below the entrance of the common bile duct: D. C., common duct; D. of W., duct of Wirsung; P., pylorus; S., sphincter.

and its distal end contained green pus; there was a chronic ulcer at the pylorus; the duodenum was enlarged.

CASE XVIII.—Female, aged forty-five years. *Symptoms:* epigastric pain, vomiting, and jaundice; pain in the left epigastrium; slight tenderness over McBurney's point. The patient had been

operated upon for gallstones two years previously; there was relief for a short time; then recurrences of the symptoms. *Diagnosis;* cholecystitis; pancreatitis. *Operation,* August 28, 1905: cholecystostomy. There was thick mucus in the gall-bladder; the pancreas was nodular; the duodenum was dilated.

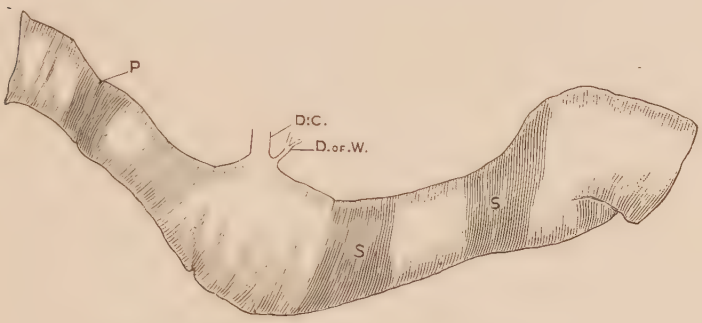

FIG. 5.—Specimen showing two narrow sphincters: D. C., common duct; D. of W., duct of Wirsung; S. S., sphincters; P., pylorus.

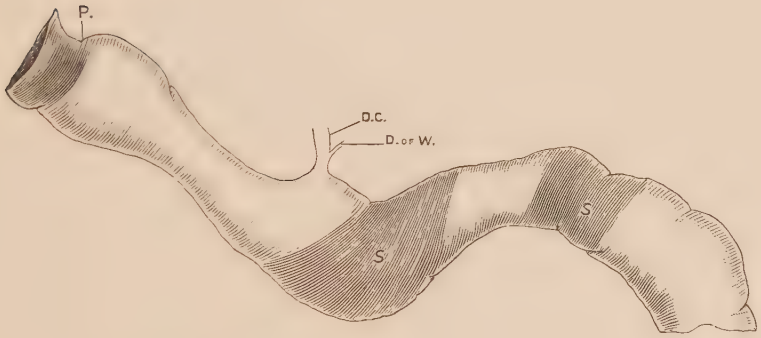

FIG. 6.—Specimen showing two sphincters with an interval of 3 cm.: D. C., common duct; D. of W., duct of Wirsung; S. S., sphincters; P., pylorus.

CASE XIX.—Female, aged eighteen years. *Symptoms:* loss of appetite and of weight. A gastroenterostomy had been done one year previously. Tenderness persisted at the upper end of, and one inch above, the incision. *Diagnosis;* gastric ulcer; dilated duodenum. *Operation,* August 28, 1905: enlarged the opening

of the previous gastroenterostomy; anastomoses of the previous gastroenterostomy. The duodenum was greatly distended.

Case XX.—Female, aged twenty-eight years. *Symptoms:* previous nervousness and stomach trouble. Now complains of variable appetite, palpitation in the epigastrium, tenderness in the centre of the epigastrium, constipation, and nervousness. *Diagnosis:* gastric ulcer. *Operation,* August 23, 1905: gastroenter-

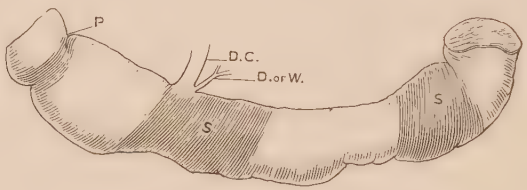

Fig. 7.—Specimen showing one broad sphincter just below the entrance of the common duct and a second sphincter 5 cm. farther down: D. C., common duct; D. of W., duct of Wirsung; S. S., sphincters; P., pylorus.

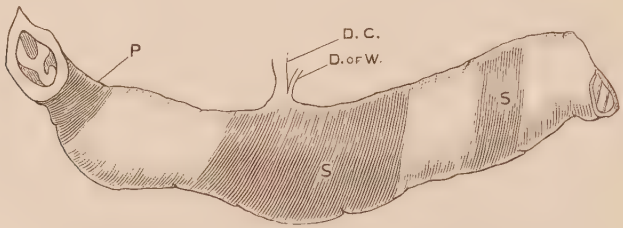

Fig. 8.—Specimen showing a broad sphincter beginning 1 cm. above the entrance of the common bile duct and extending 3.5 cm. below the duct, and a narrow sphincter 2 cm. lower down: D. C., common duct; D. of W., duct of Wirsung; S. S., sphincters; P., pylorus.

ostomy. There was an ulcer in the region of the pylorus; the gall-bladder was empty; the duodenum was congested.

Case XXI.—Female, aged fifty-eight years. *Symptoms:* burning pain in the epigastrium; constant nausea; vomiting and abdominal tenderness, especially marked in the epigastrium. A hysterectomy had been done six years previously. *Diagnosis:* gastric ulcer; dilated duodenum. *Operation,* August 28, 1905: pylorectomy; gastroenterostomy. An ulcer was found near the

pylorus; the duodenum was dilated; there was a small nodule in the fundus of the gall-bladder.

CASE XXII.—Male, aged thirty-seven years. *Symptoms:* pain in the hypochondrium extending to the back and shoulders; fever. Examination of the abdomen was negative. *Diagnosis:* cholecystitis; dilated duodenum. *Operation,* October 11, 1905: cholecystostomy. The gall-bladder contained sandy fluid; the duodenum was dilated; the appendix was held by recent adhesions.

CASE XXIII.—Male, aged sixty-four years. *Symptoms:* epigastric distress; bloating; constipation; tenderness above umbilicus; emaciation; anæmia. *Diagnosis:* ulcer of the duodenum. The patient also had a right inguinal hernia. *Operation,* October 25, 1905; pylorectomy. The scar of an old ulcer extended a short distance into the pancreas and the duodenum—probably carcinomatous; the duodenum was dilated below the ulcer.

CASE XXIV.—Female, aged twenty-seven years. *Symptoms*; gaseous distention of the abdomen; constant pain; vomiting. definite and excessive tenderness in the middle of the epigastrium. *Diagnosis:* gastric ulcer; cholecystitis; appendicitis. *Operation,* November 17, 1905: gastroenterostomy; appendectomy. There was an ulcer on the posterior wall of the pylorus extending into the duodenum; the duodenum was dilated; the appendix was adherent to the right ovary and was distended with fluid.

CASE XXV.—Male, aged forty-four years. *Symptoms:* pain in the epigastrium after eating; rigidity of the abdomen; anæmia; emaciation. *Diagnosis:* ulcer of the stomach. *Operation,* November 27, 1905: gastroenterostomy. An ulcer, 15 cm. in diameter, was located in the cardiac and posterior wall of the stomach; the duodenum was dilated; the lymphatics were enlarged.

CASE XXVI.—Female, aged twenty-four years. *Symptoms:* gastric pain; nausea; hæmatemesis; attacks of colic; extreme tenderness in the middle epigastrium. *Diagnosis:* gastric ulcer; cholecystitis. *Operation,* November 27, 1905: gastroenterostomy. There was a wide-open ulcer opposite the entrance of the common duct; the pylorus and the duodenum were dilated; the gall-bladder was distended and contained 50 c.c. of black, sandy bile.

Case XXVII.—Female, aged twenty-seven years. Severe pain in the abdomen; vomiting; fever; tenderness beneath the right costal margin and over McBurney's point; neurasthenia. *Diagnosis:* ulcer of the stomach and the duodenum. *Operation*, December 15, 1905: gastroenterostomy; appendectomy. There was an ulcer of the duodenum; the stomach was dilated and twisted on itself and contained considerable fecal matter.

Case XXVIII.—Male, aged thirty years. *Sympioms:* abdominal pain; general abdominal sensitiveness; insomnia. *Diagnosis:* gastric ulcer. The patient had been operated upon, five years previously, for appendicitis and intestinal adhesions. *Operation*, December 15, 1905: gastroenterostomy. There was an ulcer on the posterior wall of the pylorus on the duodenal side; the stomach and the duodenum were dilated.

Case XXIX.—Female, aged thirty-five years. *Symptoms:* pain in the right iliac region; abdominal distention; fever; anæmia. *Diagnosis:* gastric ulcer; cholecystitis. *Operation*, December 13, 1905: gastroenterostomy; appendectomy. There was an ulcer near the pylorus; the duodenum was distended; the gall-bladder was distended with 10 c.c. of black, sandy fluid; the appendix was cicatricial, 4 cm. long.

Case XXX.—Female, aged thirty-eight years. *Symptoms:* continual pain in the stomach; tenderness in the epigastrium; hæmatemesis; headache. A gastroenterostomy had been done six months previously. *Diagnosis:* pyloric ulcer; dilated duodenum; cholecystitis. *Operation*, December 29, 1905: cholecystostomy. The pylorus was indurated; the duodenum was enlarged and adherent.

Case XXXI.—Female, aged twenty-nine years. *Symptoms:* continual gastric pain; epigastric tenderness. The patient had been operated upon one year previously for gastric ulcer. The pain recurred. *Diagnosis:* pylorospasm; dilatation of the duodenum. *Operation*, January 1, 1905: gastroenterostomy—the opening enlarged. The gastric side of the pylorus was constricted; the duodenum was dilated.

GASTRIC ULCER, PRODUCED BY A BLOW, REVEALED BY AN OPERATION.

By A. F. JONAS, M.D.,
OMAHA.

That typical chronic ulcers develop in the gastric walls, after the stomach has been struck a direct blow, is no longer an open question. Many cases have been recorded in the literature and it would be only a matter of industry to construct elaborate tables comprising the reported cases. We soon discover, however, that the diagnosis in the vast majority of recorded cases has been made clinically and that recovery has taken place in most of them. If we search for evidence where the diagnosis was established beyond the possibility of doubt by an operation, we find the number relatively few.

There always remains an element of doubt when an intra-abdominal lesion has not been demonstrated by operation or autopsy. It is well known that injuries to the hollow viscera are frequent; that contusions and lacerations are not uncommon. It is also well known that these injuries either heal promptly or the subject becomes the victim of a fatal peritonitis. But it still often becomes a matter of dispute that an injury is followed by an acute or chronic ulcer, particularly in the stomach.

A large and varied experience in accident surgery, and particularly injuries to the abdominal viscera, has enabled the writer to observe lesions of the hollow viscera varying from simple contusions to extensive lacerations. While direct blows on the stomach are not infrequent, several cases come under observation nearly every year, grave and prolonged disturbances, how-

ever, are very rare. The direct blows inflicted over the stomach, in the author's experience, were by various objects; viz., horse-kicks, blows with the fist, kicks with the booted foot, thrust with a wagon tongue, baseball and baseball bat, falling upon a pointed stone, against the edge of the table, objects falling from a height, falling over a scantling, striking the epigastrium and one or both costal arches.

None of these produced a prolonged and permanent injury, consequently one could not resist the belief that if there be no rupture of the gastric walls, all other lesions promptly recover. Basing one's conclusions upon a personal experience with upward of twenty cases of severe blows struck over the stomach followed by prompt recovery, it is not easy to believe in the development of a traumatic gastric ulcer. If we take into consideration, however, the extensive contusions that occur after severe blows to the stomach and intestines, as was demonstrated many years ago by B. Farquhar Curtis and more recently confirmed by Petry, we can only wonder that traumatic gastro-intestinal ulcers are not more frequent.

Curtis found that, aside from bruising and laceration of the parietal structures, there occurred in ten out of forty-four experiments on dogs severe contusions of the intestine threatening perforation, most of them having laceration of some coats of the intestine. In ten cases no injury was done. In two cases the cecum was separated from the ileum, rupturing branches of the mesenteric artery. Rupture of the intestine was caused in eight cases; in two there were two ruptures.

As to the conditions favoring rupture, Curtis further demonstrated on the cadaver, that in contusion of the abdomen the intestine is ruptured by being crushed between the contusing body and bony parts of the vertebræ and pelvis. The injury is, therefore, not a true rupture but a contused and lacerated wound of the gut.

We know too that when a hollow organ is distended with fluid, food or gas, the chances for contusion or injury are increased.

If the injury consists in a rupture of the entire stomach wall,

or the contusion is so severe as to produce a necrosis ending in secondary perforation, the conditions are very simple. The progress of the case is rapid; death occurs early unless prompt surgical aid is brought to bear. It is more difficult, on the other hand, to judge correctly in cases where the injury has produced a contusion or laceration of a part of the gastric parietes, for example, the mucosa, or where an hematoma has developed between the coats of the gastric wall, *i. e.*, between mucosa and muscularis. Many of these lesions may heal in a short time. In other instances where, on account of disturbed or arrested circulation, necrosis may occur and on account of it there may be little or no resistance of the mucosa to the digestive power of the stomach secretions, or in all probability the presence of an infection may be a necessary and important factor in the production of an ulcer, which in its clinical aspects presents points of great similarity to the well-known peptic ulcer, and differs only from it in an etiological standpoint, *i. e.*, they develop rapidly immediately or soon after an injury in a person who presented a clean bill of health so far as his stomach is concerned.

The experiments of Sauerbrod have been very instructive and have confirmed the clinical findings in this class of cases. He found that blows on the abdomen of dogs, applied in such a way that the abdominal wall was driven against the spinal column catching between the two structures an intestinal coil, the latter was always contused and sometimes lacerated. In all cases where the stomach was filled and a blow suddenly applied to it, a rupture, especially of the mucosa, would always occur in the lesser curvature. These findings have been confirmed by Key and Aberg. But an observation of these lesions does not enlighten us regarding the formation of traumatic gastric ulcer, since the universal experience has been that ruptures involving the mucosa, as a rule, heal promptly. Undoubtedly injury to the stomach wall is only one factor; other factors are essential.

Vannis, in his experimental work, struck animals with a full stomach with a wooden club and, after a few days, found ulcers of irregular, sometimes serpiginous, form, and in part with crater-

like infiltrated edges. He believes that the traumatized mucosa, whose vitality is destroyed, undergoes a process of self-digestion. The infiltrated edges he thinks are due to a mycotic process.

Ritter believes, based on an observation of three cases and his own animal experiments that a separation of the mucosa from the muscularis takes place and an interstitial hematoma is developed. The detached mucosa is robbed of its nourishment, and in consequence becomes the prey of the peptonic power of the gastric juice. Rhen very properly objects to these conclusions. In his experiments he has shown that the mucosa can be detached, bruised, cut away, large areas may be resected, and still no ulcer will form. He insists that the chief factor, in addition to the traumatism, must be an infection. These conclusions have been observed by many other observers, both from a clinical and experimental standpoint.

The surgical literature does not contain a large number of cases of traumatic ulcer, that is, ulcers resulting from an injury that were shown to exist by an exploratory operation.

Jackh, in *Langenbeck's Archives*, vol. lxvi, describes eight published cases and adds one of his own. Fertig publishes a case in the *Münch. med. Woch.*, September 12, 1905. Making ten cases in all that the writer was able to find in the literature at his command, and he herewith desires to add one of his own.

C. H., aged thirty-eight years, machinist. A freight car, while standing on a side track, under which he was working, making repairs, was suddenly struck by two other freight cars loaded with coal in the process of switching, and suddenly moved forward. He was struck by the brakebeam over the epigastrium and both costal arches and he was dragged about ten feet when the car came to a standstill. He was barely able to free himself and crawl from underneath the car, which he did, and he laid beside the track about fifteen minutes before he was able with great difficulty to arise and walk to his home a few blocks distant. In about one hour after the accident he vomited the contents of his stomach, which contained streaks of blood, and soon after arriving at his home he lost consciousness with very slight intervals

of consciousness at first. After one or two hours these intervals of consciousness disappeared and he was unconscious the greater part of the next three days. His temperature, during this time, reached 105° F. He vomited at the end of the third day and his temperature became normal. Examination by his physician revealed great tenderness in the epigastric region and both costal arches, more particularly the left one, where a separation had taken place between the eighth and ninth costal cartilages. Strapping of adhesive plaster was applied, which relieved all discomfort excepting the epigastric pain. The following two weeks he continued to experience some gastric pain. Constant nausea. Appetite was impaired and food produced discomfort. He experienced a general prostration which compelled him to remain in bed. On the fourteenth day he experienced a severe boring epigastric pain, he began to vomit small masses of yellowish-greenish, foul-smelling, gelatinoid substance containing more or less blood. These masses were ejected several times daily for about three weeks. The pain became gradually worse and existed whether he had taken food or not. About the fourth week and after a liquid diet, the pain changed to a burning sensation and the emesis ceased. The pyrosis, burning sensation, was often so severe as to cause loss of sleep. Everything he ate produced distress for many hours. After a time he craved acids and tomato sauce seemed a source of gratification, otherwise he had no desire for food; later he experienced frequent eructations of yellowish-greenish mucoid masses mixed with blood. The slightest pressure over the epigastrium caused severe pain and vomiting. His bowels were constipated and moved only by artificial aid; the evacuations were black; irrespective of medicines or food; sometimes the bowel evacuations appeared like coffee-grounds. His strength gradually failed, so that every exertion produced extreme prostration; sometimes attacks of fainting. He became extremely nervous and at times irritable; his sleep was irregular and fitful. He gradually lost in weight until he was more than thirty pounds below his normal condition.

None of the above symptoms existed before the accident. He

had always enjoyed good health, especially in respect to his digestive organs.

He presented himself for examination February 1st and the following condition was noted. He appeared thin, emaciated and extremely anemic, walking slowly in a rather stooping position with the aid of a cane. His clothes were much too large for him, suggesting that he had lost much flesh. He seemed to suffer severe pain. Muscular tremor involving muscles of all the extremities. His teeth appeared defective and he has a chronic post-nasal catarrh.

On examination his abdomen was flat, somewhat retracted. The musculature, more especially the recti, was rigid. Epigastric tenderness was very pronounced. The left costal arch was sensitive to pressure, the cartilages were somewhat more prominent and thickened but had become reunited. In the central portion of the abdomen, in the umbilical region, could be seen a hand-sized prominence, which was elastic to pressure and emitted a tympanitic percussion sound, suggesting the position of the stomach, There existed no swelling or tenderness in any other portion of the abdomen. Heart and lungs and all other organs were normal. Pulse, which was small and easily compressible, was normal as to frequency. No elevation of temperature was noted.

The stomach contents, one hour after the ingestion of a test meal, indicated marked hyperchlorhydria. On inflation the lower border of the stomach was found four fingers width below the umbilicus. The organ was greatly dilated and prolapsed. These findings, together with the historical data, seemed to indicate the presence of gastric and duodenal ulcers. Accordingly a milk diet and complete rest were recommended. After a month, instead of improvement, an aggravation of the condition was noted. Another test meal confirmed the former findings. The patient's condition had become extremely bad from every standpoint. Consequently, an operation was recommended and promptly agreed to by the sufferer.

Operation. On opening the abdomen the stomach could be seen lying in the position shown on inflation. The organ being

drawn out of the wound, a partly healed ulcer somewhat smaller than a nickel was observed in the anterior and upper wall of the stomach and immediately on the gastric border of the pylorus. A second ulcer the size of a dime was located in the duodenum an inch from the pyloric ring. The pylorus itself appeared in a state of spasmodic contraction. The bile tracts and pancreas were free from disease.

In accordance with recent practice a posterior gastroenterostomy without a loop and an opening in the bottom to the stomach in accordance with the Moynihan-Mayo method, was done. Recovery from the operation was uneventful. There has been a complete relief of all the former symptoms and a cure is apparently complete.

The interesting features in our case are, first, that the clinical symptoms of both gastric and duodenal ulcers were unmistakable. Epigastric pain constant and worse after eating; nausea; vomiting of foul-smelling substances streaked with blood; gastric dilatation and prolapse and hyperchlorhydria completed a typical case of gastric ulcer.

The dark, almost black, bowel evacuations associated with epigastric and right hypochondric tenderness indicated the probable existence of duodenal ulcer. The operation demonstrated its actual existence.

The patient, his physician and his friends gave us the assurance that his digestion was normal before the accident. A severe crushing blow was administered to the stomach which was partly full. All the clinical features appeared after the accident. Consequently, we assume that the accident was chiefly responsible for the ulcer formation. The final and equally important factor in our case, infection, may have been derived from his defective teeth in part, and possibly in part from a chronic post-nasal catarrh.

THE TREATMENT OF GASTRIC AND DUODENAL ULCERS AND BENIGN OBSTRUCTIONS OF THE PYLORUS.

By ARCHIBALD MacLAREN, M.D.,
ST. PAUL.

The stomach is one of the most interesting of surgical fields; theories which have been accepted regarding digestion and dyspepsia for years are being disproved by surgical explorations of the upper abdominal cavity. "By the observation of numerous gastric operations a flood of light has been cast upon many obscure symptoms, which were formerly classed under gastralgia, nervous dyspepsia, atonic dyspepsia, or perhaps hysteria, but which we now realize are often due to distinct lesions of the stomach." (McCosh.)

The question, How may we distinguish between the medical and surgical gastric ulcer is of the greatest interest to the medical world today. We know that some ulcers cure themselves, for we find the scars at postmortem examinations, when the patient has not given any history of gastric ulcer. Many ulcers give no symptoms, as is shown by the large number of perforations occurring in patients who have never had dyspepsia. One such case came to my knowledge, a friend of mine made the postmortem examination and found a large perforated gastric ulcer on the anterior gastric wall. Shattuck says that "there are only two conditions occurring in gastric ulcer which demand operation: first, perforation; second, obstruction." We will all agree regarding the propriety of operating upon perforation cases. Here, if the perforation is due to an acute ulcer, and the opening can be closed, the wound sponged or irrigated and a large-sized supra-

pubic drain put in soon after the perforation occurs, a large percentage will recover with the aid of the Fowler position. My own experience makes me feel that gastroenterostomy in acute perforations is harmful, and the three cured cases who have had no return of their symptoms in over three years makes me feel that it is unnecessary.

In subacute or chronic perforation a gastroenterostomy may in some cases be a wise procedure.

We can also all agree regarding the obstruction cases, whether it be in the congenital obstruction of infants, obstructions by bands from inflammatory tumors accompanying chronic ulcer of the pylorus; these conditions are mechanical and demand mechanical relief. The congenital contraction presents a difficult problem, for, before the diagnosis is made, the infant is usually starved to the verge of exhaustion, and its normal resistance, which at best is poor, is further lessened by the disease.

Then, again, according to Scudder, one-third of these patients recover under proper diet. The spasm or contraction relaxes and the child outgrows the obstruction. In speaking of patients who recover without operation, one is apt to confuse true congenital hypertrophy of the pylorus with some similar condition which resembles it. As Mr. Edmund Cautley says: "I have seen several supposed cases get well without operation, but in no one of them did I agree with the diagnosis. On the other hand, I have no doubt that a mild degree of the condition can exist without proving fatal, for of this we have distinct evidence in the cases seen in older children. Yet of fifteen cases which have come under my notice, all have been verified at operation or postmortem examination. Only two of the last ten have been treated by purely medical measures and both succumbed." Scudder also makes the surprising statement that from the statistics of operated cases 50 per cent. recover. I have recently seen two of these little sufferers with Dr. Ramsey, of St. Paul; both had a pylorus which was practically closed. One died from exhaustion following a gastroenterostomy by Dr. Goodrich, of St. Paul. The other died without any operative relief, the child's condition when he reached the

hospital being so bad as to make it certain that he would not stand any operation. Before death we could distinctly see the peristaltic waves or contraction slowly passing from left to right across the child's emaciated abdomen. A postmortem in each case showed a slightly dilated stomach with a pyloric opening contracted to the size of a small probe by an extensive hypertrophy of the walls of the pylorus; on section showing a thick, white, fibrous band about 1 mm. in thickness and almost one-half inch in width.

It seems to me that there should be at least one other class added to this list, *i. e.*, relapsing gastric ulcer as suggested by Dr. Charles Greene and others. How many relapses would be an individual question. The nine complete and permanent cures facetiously mentioned by Haggard would certainly be an outside limit. That many of the chronic ulcers, with and without hemorrhages, do recover after proper medical treatment, I know from my own observations. The statement that we often hear at the operating table that this patient has had three, four, or more medical cures is not sufficient; most medical treatment is a farce. The prescribing of pepsin, pancreatin, peptinzyne, papoid and similar medicines is useless and absurd. If there is any foundation in the theory that gastric and duodenal ulcer is due to hyperacidity, then the use of large doses of alkalies one-half hour after meals would be a rational line of treatment. In questionable cases when we suspect gastric erosion or a commencing ulcer, large doses of bicarbonate of soda and bismuth have seemed to me of considerable benefit, in temporarily, at least, relieving gastric pain. As a remedial agent the stomach tube is of little value; it is of the greatest aid in diagnosis and "in a few middle-aged patients, with impaired digestions due to deformed or slightly crippled stomachs caused by the contractions of a healed gastric ulcer, the occasional use of the stomach tube gives considerable relief." (Graham.)

Proper medical treatment consists in putting the patient to bed and taking away all food by the mouth from four to six or more days, or until all tenderness on pressure over the stomach has disappeared; supplying water and nourishment by the rectum.

In 90 per cent. of these cases a week's starvation will prove sufficient, then we may commence with liquid foods, and in two or three days we can add baked potatoes, well-cooked rice, and breakfast foods, spinach and the lighter vegetables. Most of these cases will have to be careful of their diet for months, but so will surgical cases, for that matter; very few gastroenterostomy patients can be careless about their diet without suffering ill-effects.

I have been surprised at the number of fairly permanent cures which have followed the above line of treatment; some of them no doubt relapsed and have gone to someone else for an operation, but most of them I have been able to keep track of and know that they were quite well for long periods of time. The cases which were not relieved and who commenced vomiting again have usually proven to have a benign stricture of the pylorus, open chronic ulcer, or gastric adhesions. Inflammation of the gall-bladder may cause adhesions of the duodenum or pylorus and these will produce painful digestion or true obstruction. Adhesions of the body of the stomach by the interference with the normal movements of the organs may produce great disability. One of my patients, upon whom I had performed a posterior-no-loop suture gastroenterostomy, was recently reoperated upon after an interval of one year, to find that the anterior wall of the stomach was densely adherent to the abdominal incision; the pylorus was open, and the gastroenterostomy opening had not contracted. When she tried to get up and do even the lightest work she vomited as badly as before the operation; when she was put to bed she could take and retain light foods. The separation of this adhesion, one and one-half inches long by one inch wide, with scissors —the suturing of the raw surface and the covering of the suture line by a piece of omentum—relieved her of her stomach distress.

One of the greatest difficulties in dealing with these stomach cases is to distinguish between true chronic ulcer and the neurasthenic cases which they so closely resemble; careful watching for some period of time will often be necessary to distinguish between the two. I am always suspicious of the case when the operator does not find any evidence of gastric ulcer at the time

of the operation. Of course, there may be gastric erosion or fissure producing spasmodic closure of the pylorus, but such cases are medical and not surgical, as a rule, and I speak from personal experience when I say that the patients are not improved by gastro-enterostomy. I have one such case of my own, and I have seen several operated upon by others, who were worse rather than better, as a result of gastric surgery. Gastroenterostomy has been and still is the operation most frequently done for all sorts of gastric diseases; the posterior-no-loop operation as assembled by Moynihan and last described by Mayo, is by far the best operation so far proposed; it is sound in its mechanics, easy and safe in competent hands. The various operations for drainage of the stomach which have served their usefulness and have now been discarded are the anterior-long-loop, button and suture operation, which are now only used in exceptional cancer cases. Mr. Patterson and Mr. Battle think that the popularity of the posterior operation is due to fashion and that the anterior operation has advantages which will bring it back to favor. My observation is that the dragging of the heavy anterior loop causes the contraction of the opening and a relapse of the obstructive symptoms.

A few years ago we heard a great deal about the necessity of closing the pylorus after a gastroenterostomy. This necessity has in a great part disappeared since the posterior operation has taken the place of the anterior. The Finney operation has a very limited field; the Roux operation although effective is not necessary if the posterior loop is short enough, and the mortality is greater because there are two intestinal openings and suture lines instead of one. But as an operation, gastroenterostomy has been overworked. Dr. Rodman tells me that he found many reported cases of perforation and fatal hemorrhage following gastroenterostomy; many, due no doubt in large part to faulty operations, where the anastomosis has been followed by kinking or twisting of the intestine and consequent waterlogging of the duodenum. My experience in surgery of the stomach has not been great; although I have seen a large number of questionable cases, I have avoided operating when possible because the permanent

results until the past two years have not been satisfactory and the result of medical treatment has been fairly good. I have lately operated upon thirty cases—the last fifteen without a death.

The operation of the future will undoubtedly be some form of resection; in many of the cases now treated by gastroenterostomy, in chronic ulcer of the pylorus without obstruction, and in hour-glass stomach, resection is especially applicable.

EARLY OPERATIONS FOR CEREBRAL HEMORRHAGES OF CHILDHOOD.

By CHARLES H. FRAZIER, M.D.,
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Surveying that field of surgery which has to do with epilepsy, one cannot but be impressed with two facts: first, that there exists much confusion in the minds of surgeons, and neurologists as well, as to the indications for operation, and secondly, that the medical mind is becoming rather more skeptical as to the propriety of operation in a very limited number of cases. The confusion that exists may be attributed very largely if not entirely to the fact that there is little definite knowledge as to the pathology of the disease. Knowing as little as we do about the pathology it is impossible to formulate any definite system of operative procedures, applicable for various types of the disease. That the operative treatment of epilepsy should have fallen somewhat into disrepute has been due to the fact that surgeons have not exercised proper discrimination in their selection of cases and employed somewhat the same measures in all varieties of the disease.

The surgeons also are more or less to blame for our limited knowledge of the pathological lesions. It is the surgeon who has the opportunity to observe the structural changes of the tissues in the earliest stages of the disease and to the surgeon we should look for the most valuable contribution to our knowledge of the pathogenesis. His opportunities for studying the pathology may be more frequent and are more opportunely made than the general pathologist, who may not have an opportunity of examining the tissues at all, or if so, not until the process is in its terminal stage. One need only stop to think of the advantages of the surgeon over

the pathologist in the study of the morbid anatomy of lesions of appendix or stomach in their incipiency to be impressed with the fact that similar advantages are afforded in the study of the pathology of epilepsy. In this connection I may quote from a paper, by Munro (*Boston Medical and Surgical Journal*, February 4, 1904) upon the subject of trephining for epilepsy in which he said "if we can see enough cases of living pathology and eventually can group their cases in numbers sufficiently large," etc., and again "by the accumulation of such data" (*i. e.*, lesions found at operation) "from different surgeons someone in the future may be able to make use of these observations as will determine with greater accuracy which patients are likely to benefit by surgical interference." This is I have always believed, the keynote to the situation; we must observe with greater accuracy the nature of the lesion and in so doing we may be able to make a classification, based upon accurate and scientific data.

I would not venture to embrace in a single contribution every phase or every variety of this very terrible and unfortunately very common disease, for it has been estimated (Spratling, *Journal of Nervous and Mental Disease*, September, 1902) that one person in every five hundred of population is epileptic, but will confine myself to that group of cases which is associated with infantile cerebral palsy and more particularly to those cases which develop in *early childhood* and are not of congenital origin or secondary to accidents occurring at birth. If the child recovers from the immediate effects and from the early manifestation of the disease, it almost invariably suffers some permanent physical disability, as a result of the disturbance in the motor cortical cells or tracts, either a hemiplegia or monoplegia, chorea or athetosis, tremors or mobile spasm. But what is of much more serious moment, it suffers, in a not insignificant number of cases, from disorders or impairment of the mind or from epilepsy with mental defects.

Thus, in a total of 337 cases, 97 or almost 30 per cent. became epileptics. This estimate is a conservative one because there are a certain number of cases, especially in very young children,

which are not recognized as such either at the time of the acute stage or even subsequently because the patient may recover without any residual paralysis. According to Oppenheim, epilepsy is found in from one-half to two-thirds of the cases. Epilepsy not only constitutes one of the most serious consequences of the disease, but what is of even greater importance, the attacks undoubtedly tend to aggravate existing mental defects (Osler).

We are concerned, therefore, with a particular group of epileptic subjects, a group which in most instances may be differentiated from other cases by the existence of certain paralyses, with a history of having previously had an illness, characterized by fever, vomiting, delirium, loss of consciousness, and convulsions.

As Gowers has pointed out, "very few observations have been made on the condition of the brain in these cases, and those are chiefly on cases long after the onset." The opportunities for postmortem examinations or for examinations of the tissues when this process is in its more or less acute stage have not been very frequent. From what is known of the pathology of this condition, it may be said that the fundamental causes are very varied; in some cases, the structural changes are due to thrombosis or embolism, others again to hemorrhages, and lastly those which are evidently of an inflammatory nature and complicate certain infectious diseases, more especially measles and scarlet fever. It is scarcely necessary to say that there are no possible indications for surgical intervention in those cases which are due to thrombosis and embolism, so that there remain for discussion cases of hemorrhagic and of inflammatory origin.

As to those which are due to hemorrhage, in an analysis of seventy-eight autopsies in infantile hemiplegia Peterson and Sachs (*Nervous Diseases of Children*) found that in thirty-five cases of infantile hemiplegia hemorrhage had occurred in twenty-three. Further than this, it should not be forgotten that a large number of the cystic conditions may have been due to hemorrhage or embolism, and many a case of atrophy or porencephalus may belong to the same category. Sachs is of the opinion that hemorrhages are most commonly the cause of these conditions. Of

equal importance with the prevalence of hemorrhage as a cause of these palsies is the fact, as Sachs also points out, that in contrast to the hemorrhages in the adult, which are in the vicinity of the internal capsule, *hemorrhages in children occur in or near the cortex.*

While there is still cause for a good deal of speculation regarding the primary lesions, there is much more definite information about the end results. In the great majority of conditions either sclerosis or cysts, with or without porencephalus, will be found; conditions in which the function of the brain is permanently affected, because, as in sclerosis of the existence of a definite organic lesion, or because, as in cysts, and porencephalus, of the existence of certain developmental defects. Cysts are perhaps the most frequent lesions with which we meet in operations upon epileptics of this class. During the past eighteen months, in looking over records of operations for epilepsy, I find that there were three cases in which cysts were found. One of these was a young man twenty years of age (G. C., series 2, 1270, was referred to the University Hospital by Dr. Walker and placed under the care of Dr. Charles K. Mills) who when a child while convalescing from scarlet fever had an attack associated with unconsciousness and terminating with a residual hemiplegia. When fourteen years of age he had his first epileptic seizure and from that time to the present he has had a hundred or more attacks. He is still hemiplegic and his arm on the affected side is decidedly spastic.

At the operation an osteoplastic flap was reflected from the motor cortex and exposed a cyst measuring about one and one-half inches in diameter. It is not at all improbable that the cyst was the result of a hemorrhage or a hemorrhagic encephalitis, and had an opportunity been afforded to operate shortly after the onset of his illness the child might have regained power in the affected limbs in part at least and never have become an epileptic subject.

The removal of the original lesion would prevent the development of those secondary lesions which many years later resulted in convulsive seizures.

Surgical Considerations. With this very brief and imperfect review of the pathology, there remains to be considered the sur-

gical possibilities or responsibilities. What attitude is the surgeon to take as to the treatment of this group of epileptic subjects? In the vast majority of cases the patient will not come under his observation until the epileptic seizures are well established, or if he sees the case earlier than this, months and even years will have elapsed since the beginning of the process of which epilepsy is but a late manifestation. Unless one takes the stand that operation should be performed in all cases of epilepsy—relying upon the effect of operation per se—it is difficult to see upon what grounds one is justified in recommending operation in this case. What procedure at the surgeon's command can so effect a sclerotic area of the brain as to have any influence whatsoever upon the epileptic seizures? If any adhesions are found between the thickened dura and brain cortex they may be separated, but only to form again. The interposition of rubber tissue or silver-foil I am sure aggravates rather than alleviates the condition. Or what surgical manœuvre can so modify the conditions in porencephalus as to affect the occurrence or the frequency of epileptic attacks? The cysts, which are so often found associated with the porencephalic brain may be evacuated, but no precaution can be taken or measure adopted to prevent their reformation. For one, therefore, I am inclined to regard these cases as rather unfavorable for surgical intervention. I believe most of them should be grouped with these cases in which greater prospects of relief are offered by institutional rather than surgical treatment. Certainly, the most auspicious time for surgical intervention is when the processes which lead eventually to the development of epilepsy and mental defects are in their incipiency. In other words, knowing what we do of the morbid processes that cause the cerebral palsies of childhood, is the surgeon justified in recommending an exploratory operation in the first few weeks of the disease? If such were the case the treatment of epilepsy would be developing along the same lines as is the treatment of so many conditions in modern medicine, namely, toward the prevention of the disease.

As to those cases which are the result of an acute encephalitis, which is said to be circumscribed and confined to the motor region,

it would seem, at first thought, as though we were dealing with a condition for which surgery could offer no relief—a condition characterized by hyperemia, hemorrhage, round-cell infiltration, and serous exudation with œdema—or, in other words, the essential elements of an inflammatory process. In so far as concerns the acute stages of such a lesion any suggestions which I might have to make would be purely speculative. It is not at all uncommon to operate upon cases of long standing in which the brain is œdematous and in which multiple punctures of the pia are followed by a free exudation of serum and subsidence of the œdematous condition.

In some of my own cases and in some reported by others there has been a decided improvement. Whether the same procedure would have a more beneficial effect on the acute stages of an encephalitic can only be surmised.

It is the cases of hemorrhagic origin which would seem to afford the greatest possibilities of relief from surgical interference. We operate upon cases of traumatic hemorrhage not so much because of the motor disturbances, since in some cases these may be neither paralyses nor convulsions, but for the purpose of removing a clot, which if allowed to remain will organize, and, acting as a source of irritation to the cortex, may become the exciting cause of a genuine epilepsy. In the continued presence of a clot, and this is especially true of children, there is an additional danger. Not only will it act as a source of irritation, but it will interfere with the development of the brain and also lead to degenerative changes, which though beginning in the cortical cells, may extend centrally along the motor tracts. A clot lying between the inner confuse of the dura and the cortex to subcortex will early, by compression, arrest the growth and development of the cortical cells. If the clot be removed, pressure is relieved and the cortical cells will at once begin again to develop cysts, areas of softening, atrophy and porencephalus may be included among the probable consequences of pre-existing hemorrhage. The subarachnoid cysts that are found in cases of infantile hemiplegia may in many instances have been due to hemorrhage, and if operation were resorted to

promptly in such cases the prospects of immediate relief and the prevention of serious residual efforts are worth considering. In the past two years I have operated upon three cases of epilepsy associated with infantile hemiplegia; to one of these I have already referred. But the case which especially caused my interest in this subject was that of a young boy whom I saw in consultation with Dr. Charles K. Mills and Dr. De Forest Willard. The boy was thirteen years of age, of good parentage, exceptionally bright and intelligent. About ten years ago, shortly after an attack of parotitis or mumps, he suddenly developed infantile hemiplegia, which has persisted. Four years ago the patient had his first epileptic seizure and from that time to this they have occurred with increasing frequency and are now associated with loss of consciousness. The attacks are very similar in nature, the left arm is forcibly extended and immediately flexed in that position. The arm being flexed at the elbow and the wrist and fingers tightly flexed. The convulsions, which begin always in the left arm, soon became general. Not only is the child suffering from these epileptic seizures but as a result of them the patient's temperament has become very irritable and his temper at times uncontrollable and violent. When the osteoplastic flap was reflected a subarachnoid cyst was found measuring about one inch in diameter. This was evacuated and its anterior external wall excised. The operation was unattended with any difficulties and the patient reacted promptly. A little over a year has now elapsed since the performance of this operation, and it is reported to me by the child's parents that his condition is somewhat improved. This improvement, however, may be attributable to the operative interference or to the change which was made in the boy's manner of life. He was taken from school and put upon a farm, where he is free from any possible source of annoyance and lives a healthy outdoor life.

Ever since the operation he has taken less bromide and the frequency and severity of attacks have been less.

If in these cases operation is to be performed at all, it should be performed some time between the first and fifth week, not

later than this because of secondary degenerative changes that inevitably follow, nor earlier because some time should be allowed for the child to recover from the immediate effects of the illness and for the attending surgeon to confirm his diagnosis. As to the diagnosis one would have to differentiate the palsies of cerebral from those of spinal origin. In the cases of cerebral origin the paralyses are more apt to be of the diplegic or hemiplegic type, while in spinal cases the paralyses are limited to one or two limbs or to individual groups of muscles; in the cerebral palsies alone are the facial muscles involved; convulsions are of more frequent occurrence, the reflexes are exaggerated, not diminished, and there is usually the history at the onset of asphyxia, coma, and convulsions. It might not be possible nor is it important to distinguish between the cortical and the subcortical hemorrhages; in some cases there is a combined cortico-subcortical hemorrhage. The most favorable cases are those in which the hemorrhage is purely cortical, although the existence of subcortical hemorrhage should not be regarded as a contraindication. The operation itself would consist in the reflection of an osteoplastic flap which in the child could be done without any difficulty in a few moments. The motor cortex should be exposed and the clot if present removed; if the hemorrhage had not occurred in the cortex an exploratory incision should be made with the hope of finding and evacuating an intracerebral clot.

Resume. In order to put upon a rational basis the surgical treatment of epilepsy greater discrimination must be made in the selection of cases. No opportunity should be lost in operations upon epileptic subjects to observe as closely as possible existing pathological lesions. A more intimate knowledge of the pathology of the disease is necessary for the establishment of a basis upon which to determine the propriety of operative intervention and the character of the same. Epilepsy develops sooner or later in from 30 to 50 per cent. of cases of infantile hemiplegia. In many of these the lesion has been proved by autopsies to have been a hemorrhage and in children the hemorrhage is often either on or near the cortex rather than intracerebral, as in adults. The

tendency toward secondary degenerative changes, such as atrophy, and softening, the greater predisposition in epileptic subjects toward mental defects, especially idiocy, and the otherwise hopeless nature of the disease, constitutes the principal arguments for surgical intervention.

I have ventured to make this contribution to the surgical therapy of epilepsy, even though the observations are not based upon an actual operative experience, at the time when I believe operation should be performed.

If one is called upon to see many cases of epilepsy one cannot but be depressed by the fact that in so many the time has passed when surgery can offer much relief. If, therefore, any measures can be adopted which may be said to be preventive, an advance, small as it may be, will have been made in this field of surgery.

DISCUSSION ON THE PAPERS OF DRS. MAYO, PORTER, JACOBSON, BLAKE, MACDONALD, OCHSNER, JONAS, MACLAREN, AND FRAZIER.

Dr. A. J. Ochsner, of Chicago.

In connection with the mortality following operations, Dr. Mayo's paper points out in the grouping of the various forms of cases a most important condition. You will find in group No. 1 that there is a mortality of but 3 per cent. in cases of gallstones in the ducts; while in group No. 2 there is a mortality of 16 per cent. In group No. 3 there is a mortality of 34 per cent. In each of these groups the gallstones are located in some portion of the ducts, the difference being that in group No. 1 there is neither infection nor obstruction. In group No. 2 there is infection, while in group No. 3 there is obstruction. This difference existing, it is important for us to devise a plan by means of which cases belonging to group No. 2, the infective cases, can be returned to group No. 1. It is important also that cases belonging to group No. 3 in which obstruction existed should be returned to group No. 1 to reduce the mortality from 16 to 3, and from 34 to 3 per cent. That this is possible in a large proportion of cases I am certain. Many of the cases in which infection and obstruction are present can be reduced to non-obstructive and non-infective cases, if we employ the principle which we use for other conditions in surgery, namely, the principle of rest, and, as the result of the rest, the principle of drainage. In a considerable number of these cases I have found it possible to establish the principle of rest by emptying the stomach by careful gastric lavage, repeating the gastric lavage in case mucus accumulates or is secreted in the stomach. This establishment of physiological rest will often result in the disappearance of infection; it will often result in the disappearance of obstruction where the obstruction is due to an œdematous condition of the duct, so that I would in all of these cases strongly advise an attempt at making this change.

Dr. William J. Mayo, Rochester.

I wish to call attention to the vital point in connection with this subject in more than 95 per cent. of the cases that had the more dangerous condition, such as stones in the common duct or cancer, the history was prolonged, and there was practically no excuse for delay in operating until these complications were manifested.

If we can get the general practitioners to understand that delay means a greatly increased mortality from operative procedure, we will have

accomplished much. Certainly a large number of these bad cases could have been operated on early, with a mortality of less than 1 per cent.

If the patients are not operated on early, statistics show that one case in six is going to develop the more dangerous conditions, such as common duct stones or cancer.

The mortality following common duct operations cannot be considered to be due largely to questions connected with operative technique, as the necessary procedures are no more difficult in the infective cases than in the simple ones. There is a serious difference, however, which exists in the patients themselves and leads directly to the enhanced risk.

Most of the patients who had common duct obstruction could not be returned by the best of management to the simple group. They had passed beyond that as the duct had become thickened and contracted upon the stone.

After all, should we not put the matter before the patient with gallstone disease in the early stage in this way: You have a good chance now to recover, after an easy and safe operation, with a mortality of 0.5 to 1 per cent.; can you afford to run the risk of postponing operation until more serious conditions develop, which may lead to a mortality of 10 per cent. or development of cancer?

Dr. L. L. McArthur, of Chicago.

A word ought to be said in regard to the prophylactic effect of the tetanus antitoxin. Ever since the discussion of the use of diphtheria antitoxin was settled by the dictum that it must be given early enough and promptly, not even waiting for a culture to be made, the results were so gratifying that a logical application of the same principles to the tetanus antitoxin became apparent. Accordingly, for the last ten years that method has been followed in my service in the two hospitals with which I am connected, only two cases of tetanus have developed in cases there treated. Two exceptions have occurred, and these two exceptions were of the type to which Dr. Jacobson has called our attention. One was a case of interval operation for appendicitis, who developed tetanus symptoms after he had recovered from (on the eleventh or twelfth day) the operation. The other was a case in which the patient, a child, sustained an injury to the cutaneous surface of the thigh in a street-car accident, with the grinding in of street dirt into the wound. This case developed tetanus. The patient was not given the tetanus antitoxin, the druggist not having a supply of it on hand at that time.

Dr. Leonard Freeman, of Denver.

I should like to say a few words with reference to the prophylactic use of serum in cases of tetanus. Dr. Jacobson, I believe, mentioned five cases in which the serum was used prophylactically, and these patients developed mild symptoms of tetanus, but recovered. One of the cases was my own. I had very grave doubts at the time as to whether the mild symptoms of tetanus were not due to the introduction of the serum. It has been observed that the injection of the antitoxin of tetanus, as well as the antitoxin of diphtheria, will give rise sometimes to muscular contractions and to mild pains in the muscles and joints. While these symptoms are not pronounced, they are sufficiently marked to lead one into error in supposing that a mild case of tetanus has occurred when in reality the antitoxin itself is the cause.

THE OPERATIVE TREATMENT OF INTESTINAL CARCINOMA CAUSING DANGEROUS INTESTINAL OBSTRUCTION.

By HAYWARD W. CUSHING, M.D.,
BOSTON.

When one reviews the conditions of the large intestine requiring surgical treatment, the subject of intestinal obstruction is at once presented for consideration. These cases are frequently in elderly patients due to occlusion of the lumen of the intestine by carcinomatous growths. The lesion is situated in the intestinal wall, and presents in its earlier stages almost no characteristics which can be detected by physical examination. It is usually found in the descending colon and is adenocarcinomatous in character. The symptoms may be indefinite for a long time, and not until the occlusion is marked does the spasmodic pain, vomiting, distention, etc. present the clinical picture resulting from marked interference with fecal circulation. These cases, since they are usually not seen by the surgeon until he is called to relieve the obstruction, present the following complications:

1. The difficulty in determining the cause of the patient's condition.

2. The difficulty of determining its location.

3. The danger to the patient of shock from the prolonged, difficult exploration often necessary to ascertain accurately the above mentioned facts, and from the operative procedure required to radically relieve him.

For purposes of illustration I report the following clinical history of a case in which the colon was resected to relieve dangerous intestinal obstruction due to cancer.

The patient was a single man, forty-eight years of age, of Scotch parentage, and a laborer by occupation, who was admitted to my service at the Boston City Hospital on February 15, 1904. He gave the following history: That he had been well until fifteen years ago. He then suffered an attack similar to the present one, but less severe in character. For the last ten to twelve years there has been habitual constipation necessitating the more or less constant use of cathartics. In 1894 a right scrotal hydrocele was noticed which has been tapped each year since. It is now of large size. In 1902 he had an attack of pleurisy, after recovering from which he was apparently well until February 10, 1904, on which date the attack began which forced him to seek relief. This attack was characterized by abdominal pain which at intervals became quite severely acute or "cramp-like," and was referred to the sub-umbilical region. For three days (February 7th to 10th) previous to this attack there had been no dejection. On February 11th enemata were followed by a dejection. From February 11th to the 15th the bowels moved once daily, the dejections being small in amount and consisting of hard fecal masses, but no mucus or blood. There was slight nausea and vomiting after food even in small amounts. The pain after the first of the attack almost disappeared. There was anorexia and loss of strength. On February 15th he entered the hospital.

When examined he seemed to be in a fairly good general condition. His expression was somewhat anxious. Tongue was covered with a white, creamy coat. Glands not especially enlarged. Heart and lungs negative. There was a very large scrotal hydrocele. Temperature 100.5°, pulse 80. In the right side of the abdomen over the kidney-shaped area shown in Fig. 1, there was fulness and a marked tympanitic resonance. Abdomen elsewhere was only moderately distended.

During the 16th, 17th and 18th of February, under treatment, the subjective symptoms were relieved. Temperature 98° to 99.5°. Pulse, 80, 72, 85, 100. The patient was quite comfortable. He occasionally vomited after taking liquid food. High enemata (twice

a day) produced slight results. The swelling and tympanitis increased slowly, as shown in Fig. 2. On February 19th vomiting began to occur every few hours, becoming fecal in odor and character. The abdomen rapidly distended and became tympanitic. The condition of the right side changed as shown in Fig. 3. Temperature 99.5°, pulse 100 to 102. This rapid change for the worse required radical treatment, but the consent of the patient for operation was not obtained until 6 P.M. on the 20th. An attempt was then made to find the obstruction and relieve it. The

Fig. 1 Feb. 15.

FIG. 1.—February 15.

patient's general condition was at that time rather poor. There were signs of exhaustion. Temperature 99.6°, pulse 100 to 105. Face anxious. Symptoms of the 19th still existed. The abdomen was well distended. On the right the conditions shown in Fig. 3 were present. The apparent tumor seemed fully four inches in diameter and extended from the costal border to the iliac region.

Under ether an incision in the median line extending from the

Fig. II Feb. 18.

FIG. 2.—February 18.

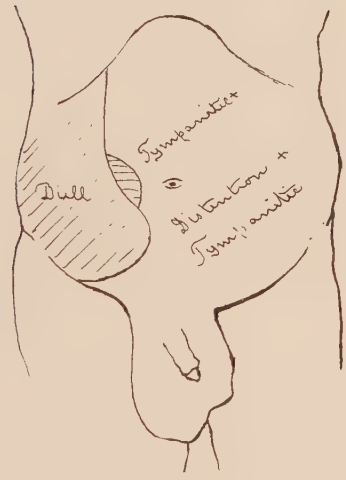

Fig III. Feb. 19

FIG. 3.—February 19.

navel toward the pubes opened the abdomen. The tensely distended loops of intestine at once protruded rendering exploration of the abdomen exceedingly difficult. An attempt was made to overcome this difficulty by incising one or two loops along the free border in hope that after their contents had been evacuated the intestine would collapse enough to give room for the hand in the abdomen. But although about 500 c.c. of liquid feces were thus removed, the remaining coils of gut were little, if any, affected and still rendered any exploration of the abdomen exceedingly difficult. This failure to empty the intestine promptly under the above conditions, has since been quite satisfactorily explained by the careful study of intestinal anatomy by Dr. George H. Monks (*Annals of Surgery*, October, 1905,[1] vol. xxxvii, page 543).

After waiting in vain for the intestine to be emptied the incisions in the gut were sutured, and the abdomen explored as well as possible, in spite of the interference from the distended coils of intestine which still filled it. No band, twist, tumor, intussusception or other obstruction could be found. The condition of the abdomen previous to operation, shown by Fig. 3, was found due to an enormously distended cecum and ascending colon, for which no cause was discovered.

On account of the patient's general condition becoming alarming, which left no time for further exploration for the cause of the obstruction, the search was abandoned and all efforts directed to the end that the patient might leave the operating room alive. To accomplish this the cecum was rapidly exposed through an oblique incision of the superjacent abdominal wall. It was then sutured in the wound so as to close off the peritoneal cavity and opened by a one-inch incision. Two or three liters of liquid, pea-soup-like feces were evacuated.

A rubber tube was now fastened into the colon wound by two superimposed purse-string sutures, and the wound after being

[1] Reprint of the Mütter Lectures on the Surgical Anatomy of the Small Intestine and its Mesentery, delivered by Dr. George H. Monks, on December 2, 1904, at the College of Physicians of Philadelphia.

loosely packed with iodoform gauze was partly closed with two silkworm-gut sutures. The median incision was closed with "through-and-through" silkworm-gut sutures. The patient was then put to bed with syphon drainage of the colostomy wound.

There was marked shock, but the patient recovered from the ether and slowly reacted under treatment. On February 21st, the day following the operation, the temperature was 101.2°, the pulse 128 to 129. The intestine gradually emptied itself through the tube in the colon into a bottle hung at the bedside, and the obstructed intestine was temporarily relieved. The vomiting ceased at once after the operation. The abdominal pain also disappeared promptly.

On February 24th the temperature had gradually dropped to 99.5° and the pulse to 98 to 105. The colostomy tube was removed and the lower bowel was cleaned by a high enema. On the night of the 24th, without any apparent reason, the patient twice got out of bed. During the succeeding days the patient continued to improve and gradually became stronger. The median incision was healed on March 7th. The colon wound closed in so that on March 20th it barely admitted the little finger. In the early part of April the patient's general condition had markedly improved. He was up and about daily. There was still a fecal discharge from the colon opening. It was then found that unless the intestine was emptied by laxatives and enemata every second day, symptoms of obstruction would begin to appear. It, therefore, seemed indicated that another attempt should be made to locate and remove the persisting obstruction. The data obtained from observation of the case seemed to indicate that it was probably a neoplasm situated in the wall of the intestine and filling its lumen. On account of the distention of the colon at the time of the first operation being limited to the ascending portion the hepatic flexure was probably its location. Therefore, on April 13th, after careful feeding and preparation, a second operation was performed.

Under ether the abdomen was opened in the median line above the navel by an incision (which before the exploration was com-

pleted was enlarged so that it extended from just below the sternum to the umbilicus) and explored.

Bands of adhesions between the intestine and the abdominal wall appeared. The separation of one of these caused an injury to the gut wall which was closed by a continuous silk suture. The intestine was empty. Contrary to expectation careful examination of the transverse colon and vicinity failed to discover anything abnormal. There was no obstruction at that point. Finally, after exploring the whole abdomen carefully without result, suddenly a small, hard, movable mass was by chance felt in the left iliac region. This was apparently a small indurated section of the gut, probably a tumor, involving the intestinal wall.

An oblique incision four inches long was now made in the left lower quadrant of the abdomen over the growth and through this wound the mass was exposed. It proved to be a tight, annular structure of the intestine at the junction of the descending colon with the sigmoid flexure. It involved the entire circumference of the intestine, forming a band about 2 cm. wide, which showed a well-marked constriction. The growth was apparently well localized. With considerable difficulty it was "walled off" with aseptic gauze, isolated by rubber bands passed through the mesentery and clamped, and about two inches of colon with its adjacent mesentery resected. No affected lymph nodes were found. The intestine was then closed by an "end-to-end" union. This was made with a "right-angled" continuous fine silk suture, reinforced at two points by a single Lembert stitch. A very thick, fat mesocolon and the slight mobility of the growth interfered much with the application of the suture. The abdominal wound was then closed by nine deep catgut sutures and an interrupted superficial silkworm-gut suture. The median wound was united by "through-and-through" silk worm-gut sutures. No drainage. Dry aseptic gauze dressing.

The operation lasted one and one-half hours, but was followed by very little shock. The recovery from ether was good and after the first twenty-four hours the patient did well. During

the next few days he was quite comfortable. There was practically no fecal discharge from the colostomy wound after the operation.

The recovery from the operation was uneventful. On the fourth day the temperature and pulse reached normal and remained so. The highest temperature, 101.8°, was on the night following the operation. The highest pulse-rate, 120, was recorded twenty-four hours later. The patient's general condition steadily improved and his strength increased. After the operation no cathartics or enemata were used until April 29th. There was a spontaneous normal dejection on the seventh day. The operation wounds healed by primary union. Patient got up on the twenty-third day. The artificial anus closed spontaneously on the eleventh day after the colon was resected and the obstruction removed. On May 5th the colostomy wound was completely healed.

The patient rapidly gained in strength and weight and was discharged apparently well on May 9, 1904.

Examination of the resected intestine showed the excised tumor to be situated in the intestinal wall and by its growth to have so occluded the lumen of the intestine as to leave an opening only 2–3 mm. in diameter. The microscopic examination made under the direction of Dr. F. B. Mallory, at the Pathological Department of the Boston City Hospital, showed the tumor to be an adenocarcinoma, and that it apparently had been resected well beyond the limits of the growth.

The patient has continued under observation until the present time, a period of two years since the removal of the cancer. He has had very little discomfort during this period and is apparently well. It was four or five months before he fully regained his strength. On May 3, 1906, I could detect no signs of recurrence. He states that there has been at times some discomfort at the site of the colostomy wound. This gradually became much less frequent than at first and at present is scarcely noticed. He says that he "can feel everything that he eats passing through there." The intestine acts normally, one daily dejection without the aid of medicine. He has recently increased in weight thirty pounds.

Examination of the abdomen is negative. The scars are firm and do not bulge on coughing. There is no tenderness.

The prognosis in this case is good since the possibility of removal and freedom from recurrence, if not permanent, at least for a term of years, in cases of this form of adenocarcinoma of the colon, has been demonstrated, especially where the growth has not spread outside the intestine. There are results of this character on record, and such has been the result of those cases which have come under the personal observation of the writer.

The above record is a fair example of one type of colon obstruction and when considered in detail presents certain features which seem worthy of attention, viz.:

1. It is important to recognize the character of the obstruction, whether it is transitory or permanent. Accumulated feces resulting from chronic constipation due to functional causes can present a clinical picture similar to organic obstruction in the earlier stages. Chronic obstruction is more apt to be obscure. The symptoms and clinical picture are not so characteristic as in the acute cases, such as strangulation, volvulus, intussusception, etc. In cancer, as a rule, the occlusion is so gradual that a diagnosis is usually made only after the obstruction has so occluded the intestine as to produce marked symptoms, pain, nausea, vomiting, distention, complete constipation. In elderly people a history of persistent constipation requiring the more or less constant use of drugs should always attract attention, and the possibility of cancer of the colon be considered.

2. Equally important is a recognition of the site of the obstruction. This is often difficult since the abdomen is a region where the anatomy and pathological physiology of its contents are varied and complex. Data obtained by external examination cannot always be accurately interpreted. For instance, it is usually accepted that an obstructed gut is distended above and collapsed below the point of obstruction. In the case just reported both external and internal examination showed the colon with marked distention as far as the hepatic flexure, while beyond that point it was of normal size if not smaller. Yet notwithstanding this

the lesion causing the obstruction was low in the descending colon. For this condition no wholly satisfactory reason has been suggested.

Again, this lesion may be so small, affecting only the intestinal wall, as to be readily overlooked by the surgeon during exploration, especially when the abdomen is filled with distended coils of intestine. It must be actually seen or felt to be recognized. Many instances have been recorded where a condition apparently probable from clinical data at hand has been found by exploration not to exist in fact. Hence the difficulty of locating such an obstruction.

3. Another problem presented to the surgeon is the expediency of finishing the operation in one or two sittings. In suitable cases there is no question but that a single operation is to be preferred. When the patient's general condition is good and the wall of the intestine normal or nearly so a growth can be excised at once, but in many of the cases certain conditions obtain which are unfavorable for immediate resection. First. The ability of the patient to endure the severe shock resulting from the prolonged manipulation. A patient is often already in a critical condition from the effects of his illness. If he can be temporarily relieved by some expedient, as an enterostomy or colostomy, the operative exposure is diminished and a life saved which otherwise would be lost. Second. The conditions for exploration and resection are much more favorable for efficient thorough work at the second operation. It is performed in an abdomen containing only an empty intestine in place of an extremely distended one. It is performed more easily, since the operation is not impeded, and consequently is finished much more rapidly. All of which, of course, shortens the exposure and diminishes the shock. By the temporary relief obtained from the first operation there is an opportunity for the patient to recover and he will therefore be in a much better general condition to endure the second. In the case reported, if the attempt to find the obstruction and resect the colon had been persisted in at the first operation the patient would probably have died at once. Third. The chances of successful union are much greater when a normal empty intestine is sutured than when

a semi-paralyzed one full of stagnant feces, toxins or ptomains, is the site of operation. At the primary operation the intestine is apt to be dilated, its muscle exhausted, its wall thickened and œdematous, the contents especially septic, in short, the whole situation is most unfavorable for successful wound union. In a recent article on this subject Dr. J. W. Elliott[1] states that the mortality from the usual operation of enterectomy with immediate suture is 50 per cent. at least in the hands of the best surgeons and in some hospitals as high as 85 per cent. The principal cause of death is septic peritonitis due sometimes to infection by intestinal contents at the operation, but more often to the fact that the most perfectly placed sutures or mechanical devices do not hold. He attributes the giving way of the suture to the diseased condition of the bowel at the time of operation. He recommends enterostomy or colostomy with later enterectomy in patients unable to bear primary enterectomy and regards this as the operation of choice in all critical cases of intestinal obstruction. The method of operation in two sittings is not new. It has been practised and published by many surgeons of note, but notwithstanding this its value is still often lost sight of in the surgeon's zeal to complete his work at one sitting. But in these cases temporary relief is of far more immediate importance than the removal of the disease. I, therefore, wish to emphasize the importance of this method.

4. Another fact to be considered is the futility of an attempt to rapidly empty a distended, half-paralyzed intestine by incising separate coils. Such incisions have only an immediate local effect. To accomplish the desired object the drainage must be continued for several hours. The surgeon cannot wait so long for the necessary result. The slow emptying of the incised gut, as Dr. Monks has explained, is caused not only by the sharp curves and kinks which the mesentery causes in a distended intestine, but also to external pressure and especially to the gas and semi-liquid contents which act like plumbers' traps. The fluid portions are in the dependant loops and obstruct the pas-

[1] The Management of Certain Critical Cases of Intestinal Obstruction with Report of Cases. Annals of Surgery, 1905, vol. xlii. p. 668.

sage of gas. The gas is in the upper part of the coil and cannot pass the liquid. Neither gas nor liquid can pass on without the peristaltic wave, which is absent in a paralyzed gut. But when an artificial anus is made and continual drainage through a tube is established the intestine after a time is able to empty itself and gradually recovers. Both the above facts were demonstrated in the case of the patient under discussion, *i. e.*, the futility of immediate and the success of continued drainage.

5. The question arises also in these cases, where first a palliative and after relief a second radical operation is performed, as to the comparative value of internal procedures such as lateral anastomosis for the purpose of "side-tracking" the obstruction, or of the method of external drainage, as by a colostomy. Some operators prefer the internal method; others select the internal for the less severe cases and the external for the extreme ones; while another set prefer the external in nearly all cases. There can be no question that in some cases where the intestine is in good condition this internal method can be safely performed and possesses advantages which readily suggest themselves. But in the severe cases where the gut is in an abnormal condition the external drainage has more advantages. One has positive knowledge that the drainage is efficient. If necessary it can be assisted. It has also occurred that a section of paralyzed gut from absence of peristalsis has caused as effective an obstruction as a strangulation, and unless the anastomosis in such a case is beyond the paralyzed area the patient would not be relieved. Again, operations done on intestines under these conditions and with contents of such a character are often followed with marked local reaction. I have seen the resulting œdema at the point of suture so great as to occlude an opening having the same lumen as the gut. By the external method such changes can be at once noted and treated. One always has a much more accurate knowledge and control where local conditions are open to inspection and manipulation. Therefore, it would seem wise to employ the external method unless the surgeon can feel sure that the condition of the intestine is normal or nearly so at

the point of suture. There is no objection to the temporary fecal fistula from fear that it cannot be closed. The tendency is to spontaneous closure after the obstruction is relieved. In this case it closed spontaneously on the eleventh day. If this does not occur it can usually be closed by operation. The objection has been made that the presence of an open fecal fistula greatly increases the danger of infection at the second opening of the abdomen. It is true that this danger exists, but by proper preparation and technique it can be avoided. In the case reported an extended exploration of the abdomen was made through a median incision and the colon was resected through an iliac incision notwithstanding a fecal fistula had been emptying the cecum on the right side up to the day of the operation.

6. It is also claimed that the delay resulting from postponing the radical operation offers an opportunity for increased growth and extension of the neoplasm, and for the production of pathological changes in the adjacent tissues unfavorable for operation. On the other hand, however, in those cases where the tumor is found it can generally be isolated and sutured outside the abdomen by one of the several methods already in use. Then at the second operation the growth can be excised and the colostomy opening closed. When the obstruction cannot be found the operator has, of course, no choice. He must drain externally. He has nothing to resect.

7. In conclusion I would call attention to the method of multiple incisions for an extended exploration of the abdomen in place of a single long incision. By this method important structures, such as nerves, vessels, and muscles, remain uninjured and the patient escapes the disagreeable after-effects of such injuries. Also an incision directly over the area in question gives direct access to the site of operation in place of the indirect approach obtained only by powerful retraction of the edges of an incision placed at a distance. No single incision can be placed in the abdomen which will possess the above mentioned possibilities without much increased risk to the patient and injury to important structures of the abdominal wall. The accompanying photo-

graph[1] shows the results of this method. The two wounds in the median line overlap so that the resulting scar is only two inches shorter than the distance from the xyphoid tip to the pubes. There is a four inch oblique scar in the left iliac region and a rather broad, depressed, three inch oblique cicatrix in the right iliac

FIG. 4

area at the former site of the temporary artificial anus. All are firmly healed and show no tendency to hernia. The tonicity of the muscles is apparently normal.

[1] This photograph was taken on May 12, 1904. The resection wound now (May 3, 1906) appears almost as a line scar with no suture marks. On account of some error in printing the photograph shows a reversed or "mirror" picture; the right colostomy scar appearing on the left and the left resection wound appearing on the right.

MEDICO-MILITARY NOTES IN MANCHURIA.

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THE Russo-Japanese conflict of 1904 and 1905 has become a matter of history. With its causes, conduct, and political, sociological, or militant results we, as physicians, are not concerned, but, as such, we are immediately interested in its military sanitary conditions, management, and outcome, while remotely these can but deeply concern us in their application to our own military circumstances.

The remarkable sanitary results achieved by the belligerents in Manchuria have taught the world:

1. That there is no legitimate reason why, in war, the mortality from disease should exceed that from traumata.

2. That the extraordinarily large excess of deaths from battle-field injuries over those from disease, obtained for the first time in history, is directly due to the observance of well-established hygienic rules, proper sanitary organization, sufficient *personnel*, and adequate *matériel*, not to mention persistent fighting.

3. That, so far as known to me, this war has developed nothing new in medical treatment or surgical technique. Its one lesson for us is summed up in a single word, "*prevention*."

Without delving too deeply into statistics and burdening you with a mass of figures, I will here simply epitomize the official medical reports so far as known to the Russian military authorities at the date they were given to me in Harbin, October 2, 1905.

From the beginning of hostilities, February 10, 1904, to September 1, 1905, the hospital records account for 352,412 cases, exclusive of the killed and missing, and of the Port Arthur statistics, then unknown to the Russian authorities.

Of these cases, there—

Died	8,983
In hospital—of disease, 4790; of wounds, 3008.	
In quarters—of disease, 652; of wounds, 533.	
Discharged for disability	24,255
Transferred west of Baikal	120,394
Recovered	173,645
Remained under treatment	25,135
	352,412

The question will naturally be asked, What was the death-rate among the 120,394 "transferred" cases? I can only answer this by saying that in consultation with the statistical officer on September 18, 1905, he informed me that the total number of deaths from disease was then 18,830.

The foregoing table accounts for but 5442; so we must assume, if my information and notes are correct, that 13,388 of the "transferred" cases died of disease. I have nothing to indicate how many of them, if any, died of wounds.

In other tables furnished me at the same time, there are noted 180,682 additional cases of battle-field casualties, of which there were—

Killed	19,467
Wounded	121,486
Missing	39,729
	180,682

Combining the two tables, we have 533,094 cases, of which there—

Died of disease	18,830
Died of wounds	3,541
Killed in battle	19,467
Missing	39,729
	81,567

The factor of the "missing" is a very large one in the problem of proportional losses.

The number of reported "missing" is extraordinary, nearly twice as great as the identified killed, and five-fold more than the Japanese reported "missing." In the German army, during

the Franco-Prussian War, the proportion of the "missing" to "wounded" was about 1 to 5, whereas the Russians reported 1 to 3.

When the circumstances of the conflict in the Far East are considered, it will be seen that the Russians were driven from every battlefield and compelled to abandon their dead, which, in the absence of specific information as to death, they could but carry as "missing." It is not conceivable that many, if any, Russians deserted, as there was no place to desert to, except to the enemy, in which event they would have been reported, at least by name, to their own authorities, as in the case of other prisoners. So it would not be unreasonable to count all the missing as dead, which would give 62,737 dead from battle casualties to 18,830 from disease, or 3.3 killed to 1 death from morbific causes. It would, however, bring us well within the bounds of probability if we applied the German results to the proportion between the Russian killed and missing, 1 to 1.5, which would give, approximately, 37,642 killed and 25,095 missing, or almost exactly 2 killed to 1 dead from disease, which, at least until the statistics are crystallized, may be accepted as the probable ratio.

This gives approximately .62 missing, .95 killed, and 3 wounded, which closely approaches the German ratio of .54 missing, .75 killed, and 2.83 wounded.

It is not probable that the Port Arthur statistics will affect this proportion, except as to "missing" of which there should have been but few, nor are they likely to change the relation between the number dead from disease and that from violence.

As the population is an essential factor in determining the rate of mortality, I will give such information as was obtainable during my tour in the Far East, it being understood that until peace was finally concluded, no secrets were more jealously guarded than those which might in any way convey to the enemy the strength of the opposing forces.

Kuropatkin, who, immediately preceding the outbreak of hostilities, was Minister of War, and certainly had every opportunity to know the facts, stated explicitly that Russia was wholly unprepared for war, and in fact at the time the Japanese made the naval attack at Port Arthur, "instead of concentrating troops, we (the Russians) were actually removing them thence." I have been

informed that at the beginning of hostilities there were in the Far East less than a hundred thousand Russian soldiers. We know that the theater of operations was nearly six thousand miles from Russia, and that the single track railroad connecting them was not completed, and was incapable of delivering more than two and a half trains daily. I quote further from Kuropatkin: "In spite of our (Russian) apparent superiorty in number of battalions, we were numerically inferior to the enemy. Thus at Liao-Yang, we had altogether 135,000 bayonets, at Sha-ho 145,000 bayonets and at Mukden between 275,000 and 290,000 bayonets." Add to these figures 16 per cent. to cover the other fighting arms, and we find that the Russian forces numbered at Liao Yang, 156,000; at Sha-ho, 168,200; and at Mukden, 336,400.

After their retreat from Mukden, there remained in the Far East altogether hardly 300,000 Russians. In the meantime the military mill at home had begun to grind rapidly, the railroad was completed and its capacity multiplied, and the mobilizing machine finally worked smoothly, so that in August the combatant strength reached 870,000, and when peace was declared the Russians actually had 1,132,000 men east of Baikal.

The total number of the Russian military population may be estimated as follows:

Present when war closed	1,132,000
Dead from disease	18,130
Dead in hospital and quarters from wounds	3,541
Killed in battle	19,467
Missing	39,729
Taken prisoners (estimated)	60,000
Returned to Russia (after deducting one-third sent back)	80,283
Discharged for disability	24,255
	1,377,405

Add to this the strength of the Port Arthur garrison, and it will be seen that the total Russian military population in the Far East numbered approximately 1,400,000 men, giving a mortality from disease of 13.4, and from wounds, including part of missing, of 26.8 per thousand.

The scope of this paper does not permit of any detailed account of the sanitary organization, *personnel*, or *matériel* of the Russian armies in this war—very important matters, which cut no incon-

siderable figure in determining the excellent sanitary results—so I shall at once proceed to the consideration of the morbific and traumatic circumstances of the campaign.

SPECIAL DISEASES.

It goes without saying that the time for a decisive discussion of the sanitary statistics of the war in Manchuria has not yet arrived. It took a number of years for the statistics of our Civil War to crystallize into their present form, and we must expect this to be the case with the statistics of the Russian and Japanese armies in the war of 1904 and 1905. General Kuropatkin himself stated, six months after Mukden, that he did not then know whether he had 275,000 or 290,000 bayonets at that battle. I find by reference to my notes that on July 29 to August 11, 1905, the following telegraphic report was sent to the Emperor:

	Officers	Men	Total
Sick	975	24,004	24,979
Wounded	52	1,313	1 365
Grand total			26,344

Of the cases within the theater of war on that date, there were under treatment for—

Typhoid fever	1151
Typhus fever	22
Dysentery	418
Anthrax	2
Variola	21
Scurvy	?33

From the beginning of the war up to July 1 to 14, 1905, there had been under treatment for—

	Cases	Deaths
Typhoid fever	10,449	1041
Typhus fever	201	35
Relapsing fever	170	11
Dysentery	5,456	256
Variola	209	12
Scurvy	1,180	10
Measles	11	1

Report of morbidity on August 1 to 14, 1905, handed me by Dr. Gorbacevich, September 5, 1905, reads as follows:

	Wounded	Sick
Officers under treatment	38	945
Enlisted men	1116	26,796

The infectious diseases on that day were:

Dysentery	677
Dysentery, pseudo (?)	181
Gastro-enteritis (epidemic)	299
Typhoid fever	2709
Typhus fever	19
Grippe	1013
Relapsing fever	9
Malarial fever (intermittent)	473
Anthrax	3
Erysipelas	71
Scurvy	281
Measles	3
Small-pox	21
Total	5759

This report does not seem to agree with that sent to the Emperor.

MORBIDITY AMONG THE RUSSIANS IN THE FAR EAST.

On August 31 to September 13, 1905, there were—

	Officers	Men	Total
Sick	1024	23,489	24,513
Wounded	30	592	622
Grand total			25,135

The diseases being:

Typhoid fever	5287
Dysentery	646
Typhus fever	40
La Grippe	1089
Malarial fever	559
Anthrax	1
Erysipelas	41
Scurvy	104
Small-pox	4
Measles	4

From the foregoing it will be seen that the morbidity experience of the Russian armies in the Far East has been different in certain important particulars from that in recent wars. There was, to be sure, typhoid fever and dysentery in not inconsiderable amount

but malaria cut very little figure, while mumps and measles, which we always look for, practically failed to appear. There was a considerable amount of scurvy, probably much more than is of record, and venereal was of little moment. In fact, the comparatively small number of deaths from disease (18,830) indicates a state of healthfulness unequaled in military history. The question naturally arises as to why this was so, and this I will endeavor to explain.

The Russian peasant who reaches the age of maturity is the survival of the fittest; for the conditions of his life from the beginning are such as only the strongest can endure. Huddled together with the rest of his probably large family in ill-constructed and unventilated habitations, poorly fed and worse clad, the child

FIG. 1.—A soldier's dinner.

grows up in an atmosphere of privation, is subjected to all the diseases of infancy, endures the rigors of a harsh climate, and survives only because of his own intrinsic resisting powers.

Owing to Russia's enormous population, the amount of material available for military purposes is practically unlimited, and from this material she took the best for service in the Far East. Starting in perfect physical trim, the men of the mobilized units traveled slowly for two months across the continent of Asia, under constant observation and frequent critical inspections, so that every man who by any chance might have been suffering from latent infection at the beginning, or who developed such infection *en route*, was at once separated from his command. Thus it was that the troops

reached the theater of operations free from infection, and in good condition to resist the morbific influences they would necessarily be subjected to in active service.

Of the climate of Manchuria little need be said here. That part of the country I saw (Harbin region) reminded me of our own northern Mississippi Valley in many respects—soil, vegetation, temperature, streams, etc. The summer is comparatively short and there are many warm days, while the winter is correspondingly long and cold, the mercury lingering around zero, and falling much below it in January and February. In July and August is the rainy season, during which there are at least daily showers, and often continuous downpours, the result of which is that the whole country goes into solution. The snowfall is light, and the snow does not remain on the ground for any length of time, being blown away by the wind or vaporized by the sun.

I was told that the prevalent diseases among the natives are typhoid fever, dysentery, and small-pox. In 1899 bubonic plague appeared in Newchwang, but was confined to that region. I heard of but one outbreak of plague within the Russian lines during my sojourn in Manchuria. This occurred at Dgai-lai-noir, a station on the railroad not far from the border, September 22, 1905, just before I started home, and seems to have been accepted by the authorities as veritable plague. The disease was apparently confined to one family, eleven of which died. As strict quarantine precautions were at once instituted, I presume there was no extension of the infection, though I left the country before this could be determined. In 1902, a quite severe epidemic of cholera began at Vladivostock and reached westward to Harbin, but no cases of the disease were reported while I was in the Far East.

It is important to add that there are but few mosquitoes, and those I saw belonged to the Culex group. During the rainy season the common house-fly swarmed in countless numbers, and I was forced to protect myself from their nightly attacks by using my mosquito-bar.

The conditions of the campaign in Manchuria until after the battle of Mukden (March, 1905) were such as to demand frequent changes of camping-grounds, there being at least one battle monthly,

so that before Mukden the army was not exposed to great danger from soil pollution. During the Russian occupation of Mukden, and subsequent thereto, until May, 1905, the troops were, for the most part, quartered in "dugouts."

The army ration was adequate and well balanced, but much of the time all its components were not obtainable. During the winter, I was told, vegetables were scarce, and the dietary was largely meat, bread and tea.

The Russian food habits and method of cooking are ideal, from a military standpoint. Everything except the bread is boiled, and is thus not only thoroughly sterilized, but is placed in the best possible condition for assimilation. Moreover, the universal use of soup and tea reduces the demand for raw water to a minimum, and largely eliminates the probability of infection from this source. The Russians, though constantly driven back, were not demoralized. Attacked furiously and persistently by overwhelming numbers, this army was never captured, and was always quite as ready to fight, though not, until the last, so well prepared as was its adversary. So the moral effects of persistent defeat cut little or no figure in the mortality bills.

From the foregoing outline of sanitary conditions obtaining among the Russian forces, it would have been easily possible to predict what the sanitary results must be.

Typhoid and bacillary dysentery were endemic in Manchuria, and these diseases were bound to appear in the army with greater or less virulency, even though the troops arrived in perfect health and as a rule lived rationally. I say "bound," because these infections were widespread, and, under the conditions of military life, could not be wholly avoided. The question for us is, Was the best done that the conditions permitted?

In attempting to answer this, I will briefly consider the etiology, prognosis, and results of some of the diseases specified, especially of typhoid fever and dysentery.

I think that, in the light of present experience, we are justified in believing that certain factors of dissemination of typhoid infection cut a much larger figure in camp typhoid than in house typhoid. Based upon the report of the board appointed to investigate the typhoid epidemic in our camps of mobilization in 1898, there

seems to be little doubt that flies and personal contact were the important factors in spreading the germs, while water was secondary or even negligible. This conclusion, which was certainly revolutionary, and which, I think, is largely justified by the evidence, is accepted by us more freely than it is abroad, where the fly and personal convection are not so seriously regarded.

In discussing the causes of typhoid in the Russian camps, Dr. Gorbacevich, chief medical inspector, stated his views to me as follows:

1. The fouling of the surface of the ground by infected excrement.

2. Constant employment of men in the trenches. (Soiling with earth and exhaustion.)

FIG. 2.—Hospital tent.

3. Impossibility of personal cleanliness in camp during the rainy season, which is the typhoid season among the natives.

4. Crowded state of the military population in camp, and the unaccustomed conditions of military life.

5. The infection of drinking-water by surface-washing, especially during the rainy season.

Dr. Gorbacevich further stated as his opinion that flies had nothing to do with the spread of typhoid fever in the armies of the Far East, though they were an important factor in spreading dysentery and anthrax.

He further said that typhoid fever is epidemic in Russia during cool weather, reaching its maximum in October and November, and thereafter diminishing until February, when it disappears.

This is the rainy season in southern Russia, *but there are no flies.* In northern Russia the epidemic disappears with the coming of snow. All the Russian physicians with whom I conversed on this subject agreed with the views expressed by Dr. Gorbacevich.

Nothing is more certain than that typhoid fever is a water-borne disease, and I think that we are perfectly justified in believing that infected water is the chief cause of typhoid fever in house-dwellers, for they have no open sinks and flies are excluded. But with tent-dwellers the conditions are different, for in military camps the population is dense, the sinks open, personal cleanliness and camp police often indifferent, infection almost always present, and, during the beginning of the typhoid season, flies always abundant. Here the man and the fly are the disseminators of typhoid fever.

Before considering several of the facts regarding typhoid fever as seen in Manchuria, I will briefly state what seems to be the accepted views of the medical profession on the role of the fly in disseminating the bacillus typhosis. The report, above referred to, of the board on typhoid fever in our camps of mobilization, in 1898, of which disease the board states that there were over twenty thousand cases and a mortality of seven per cent., indicates that water played an unimportant part, but that the infection was carried by flies, dust, and personal contact.

Veeder asserts that flies are the chief factor in transmitting infection during the autumn, the period of most pronounced activity of the disease, a conclusion reached from an investigation to determine the origin of a local epidemic. Interesting experiments were instituted by Ficker to determine if flies could be infected by feeding on typhoid cultures, how the bacilli acted within the insects, if flies could transmit the infection to human beings, and if so, for how long a period. The conclusions reached were, that the common house-fly could eat the typhoid bacillus without danger to itself, and that it could transmit the infection for a period of twenty-three days. The bacilli were found in the head, wings, and legs on the fifth day and in the intestines on the ninth day after the ingestion of the infected material.

That personal contact cuts a considerable figure in the transmission of typhoid fever is shown by the investigation of Tolay-

voch, who reports that between 1881 and 1899, 6.3 per cent. of the cases of typhoid fever occurring in the German army were hospital infections.

It must not be inferred from the foregoing that I am inclined to disregard the importance of water as a cause of typhoid infection. This has long passed the period of surmise, and has become universally accepted. Certainly, in the light of experience, no military sanitarian can ignore the pernicious effects of the average raw water. Indeed, I have contended that the use of boiled water should be as much a part of military routine as the use of boiled potatoes or any other cooked food. In campaign our only safety lies in regarding all water as infected. This involves the training of our soldiers to use boiled water at all times, and the constant employment of some sterilizing apparatus with a *personnel* to care properly for it. The extra work and cost involved would amply be repaid by the decreased non-effectiveness of water-borne diseases.

I believe the campaign in the Far East fully sustains the position heretofore taken by military sanitarians regarding camp typhoid, and it certainly shows how difficult it is to exclude this disease, no matter how favorable the conditions may be.

It has already been shown that the Russian soldier reached the theater of war free from infection, and that he campaigned in a country where typhoid fever is endemic. Let us now consider the movement of this disease during the war.

By reference to the table showing the movement of sickness from the beginning to July 1, 1905, it will be seen that 10,449 cases of typhoid fever had come on sick report, of which 1041 died in Manchuria.

I learned that on July 18, 1904, there were 100 cases in hospital, of which 50 came from the front; October 26, 1904, 4350 cases, of which 3700 came from the front; and on December 31, 1904, 900 cases, of which 800 came from the front.

From January 1 to July 1, 1905, there was a daily average of 175 cases of typhoid fever on sick report. There were on—

July 15, 1905	800
July 23, 1905	1500
August 1, 1905	2400
August 15, 1905	3500
August 23, 1905	4400
September 1, 1905	5287

I am indebted to Dr. Gorbacevich for the following table:

Typhoid Fever During August and September, 1905. (*Including Last Week in July.*)

	Rate per 1000[1] of all diseases.	Actual No. of cases of typhoid.
Fourth week in July, 1905.		
First army		234
Second army		394
Third army		166
Rear army		166
Preamur district		19
Total		979
First week in August, 1905.		
First army	34.7	180
Second army	39	254
Third army	29.9	66
Rear army		123
Preamur district		20
Total		643
Second week in August, 1905.		
First army	22.2	167
Second army	35.5	285
Third army	34	157
Rear army		354
Preamur district		109
Total		1072
Third week in August, 1905.		
First army	17.4	199
Second army	26.5	193
Third army	27.9	86
Rear army		227
Preamur district		51
Total		756
Fourth week in August, 1905.		
First army	19.2	256
Second army	31.7	148
Third army	20.8	132
Rear army		103
Preamur district		54
Total		693

[1] The rate is based on the strength of the respective armies. The three field armies had a combined strength of 729,000. Of the cases under treatment, 9.1 per thousand were in hospital.

	Actual No. of cases of typhoid.
First week in September, 1905.	
First army	193
Second army	132
Third army	73
Rear army	70
Preamur district	36
Total	504
Second week in September, 1905.	
First army	82
Second army	97
Third army	64
Rear army	55
Preamur district	40
Total	338

On September 16, 1905, the total number of cases of typhoid fever under treatment was 5898.

Information from another source was as follows:

Typhoid Fever in July, 1905.

	Officers.	Men.
Taken sick	136	2662
Died	3	359

Typhoid Fever in August, 1905.

	Officers.	Men.
Taken sick	149	3884
Died	6	672

From the beginning of the war to September 1, 1905, there were 17,035 cases of typhoid fever, of which 2077 died.

It will be observed that there are considerable discrepancies between the statements of the different authorities as to the statistics. Such must be expected and averaged. Statistics take a long time to crystallize, and during the process are constantly changing, though always pointing in the direction of the final permanent form.

There was a steady decrease in the number of cases from the middle of August, which, it is reasonable to assume, continued until the normal endemicity was reached. This decrease was undoubtedly due to the stricter enforcement of sanitary orders,

the observance of which had been considerably relaxed. The best evidence of the good results following such enforcement is obtained from our own experience in the Spanish-American War, in which typhoid was reduced from 5 per cent. in September to a fraction of 1 per cent. in December, 1898.

It might be well here to consider some of the individual and collective habits of the Russian soldier-man as causative factors in the dissemination of typhoid infection.

I have heretofore stated that the preparation of the ration was ideal from a sanitary standpoint, the food reaching the soldier hot, diluted, and with every bit of its nourishment in the best condition for easy assimilation. His favorite beverage, tea, de-

FIG. 3.—Hospital ward.

mands the ingestion of a large amount of hot, sterile, and stimulating liquid. His bread is a more likely source of infection, but being made from a flour containing all the elements of the grain, it promotes peristaltic action and keeps the digestion regular. I looked with suspicion on the bread as an inviter of flies and of hand and mouth infection. This possibility seems to have impressed itself upon the Russian physicians, for I observed in the venereal ward of the naval hospital at Vladivostock that every patient was required to keep his ration of bread in an individual bag hung at the head of his bunk, and was not permitted to expose it, except at meal-time. Here is a note I made August 25, 1905, at the Etape eating-station, Gungalin:

"Contiguous to the bakery are a number of kitchens, and in the open air many tables, at which the men were standing eating their rations in apparent content. I watched the process with interest. On the table in front of a squad was a dish of soup and one of cassia (buckwheat), and scattered around at convenient points, chunks of black bread. Each man was provided with a wooden spoon (individual) about the size of a large tablespoon, which he dipped indiscriminately into the soup, the cassia, and his mouth; chunks of meat carved with a jack-knife were eaten from the hand. I did not observe many flies about the tables this A.M., but on other occasions have seen them swarming on the food, the tables, the men, and everything in the neighborhood, including the sinks. The possibilities in the spread of typhoid

FIG. 4.—Officers' tent.

under such conditions are great, especially when the sink habits of the men are considered."

I think that this war has demonstrated, what is now accepted by us, "that flies are, under active service conditions, one of the most important disseminators of the typhoid germ, and that soiled hands cut no small figure."

It will be recalled that the troops had been in the same camps from shortly after Mukden. Until May they had burrowed in the ground, and thereafter had gone under canvas. The camps soon assumed a state of permanency, and were generally well kept, to outward appearance.

The Russian soldier's tent is square, with nearly a flat or gently sloping roof.

Its dimensions are: Height to peak, 7 feet 8 inches; to eaves, 5 feet 2 inches. The walls actually measure 6 feet, but with the slope the tent is but about 5 feet at the eaves. Its area is 12 by 12 feet, and its maximum occupancy twenty men. The tent is pitched on a center-pole, and inside at each corner is a corner-pole. Ropes sewed into the canvas of the roof run from the center to the corners. The length of the center-pole, which is jointed, is 7 feet 8 inches, and of the corner-poles, 5 feet 2 inches. There is a long guy-rope at each corner, which is secured to a large tent-pin 3 feet long and 3 inches in diameter. The walls and the roof are separate, the former being suspended from the latter, the space between them serving for ventilation. This is covered by a flap sewed to the roof. The door is at the point where the ends of the wall meet. The shelter-tent was in evidence. In fact, it was almost universal at the front. This tent is much like our own, but instead of being pitched for two, I observed that a squad of six usually combined their shelter halves.

The most comfortable arrangement I saw was a camp in which the tents were pitched on a turf wall two and one-half feet high. Within, on either side, was a platform of boards, separated by a narrow passageway. The platforms and aisle were covered with Chinese matting, and the tents presented a very neat appearance.

This plan of fixed walls was quite generally followed, even when shelter-tents were used, and there was always an attempt made to get the men off the ground level, even if nothing but an earthen platform was available. I observed many tents with wicker-work walls, which certainly promoted ventilation.

Some of the tents were so badly worn that, *per se*, they no longer afforded shelter, and all sorts of material, chiefly mud, were used to patch them up; but, as a rule, they were in good condition.

Of course, everything that tended to fix permanently the tent prevented its frequent removal to another site, and the aeration of the occupied ground, so necessary to the healthfulness of the tent-dwellers.

I am informed that before the large increase in the number of typhoid cases, very little attention was paid to the regulation which required the construction and use of camp latrines, the soldier

preferring a neighboring copse or swale to the uninviting latrine, and I remember to have seen very few vessels for night urination. I found in a note made at Gungalin, July 28, 1905, the following: "So far as I have observed in going about here, there is very little conservancy of pits and sinks." Later, there was a thorough house-cleaning, but this did not occur until after the typhoid epidemic had become established. The police of the camp-grounds was usually excellent, when such was at all practicable. But with the mud a foot deep, police of place or person was impossible, and the soil and the men soon became mutually toxic. The sink habits of the men regarding personal cleansing, I believe, cut some figure in disseminating typhoid germs. Paper was scarce in Manchuria. At best, newspapers are not very plentiful among the Russians, and the men had nothing to cleanse themselves with except leaves or grass, and not always these, so the cleansing was done, if done at all, with the fingers, which, in turn, were wiped off on the most convenient thing, as there was nothing else to do.

Deep wells (sixty to eighty feet) were dug for the use of the troops.

The standard regulations governing the use of water were quite drastic. They read as follows:

"The drinking of raw water is prohibited, except for spring or well water free from the possibility of infection, which will be determined by physicians, after consideration of the sources of the spring and the construction of the well."

"Muddy water containing suspended matter not traceable to its source must be clarified," etc.

"Water suspected of being pathogenically infected must not only be clarified but purified by the indicated means."

"The responsibility for the adoption of the means devolves upon the surgeons of the units and hospitals."

The rules given are well known here, generally accepted, and need not be repeated, though there might well be a constant reiteration of the following regulation: "The best method of sterilizing water is by *boiling* it, and the most practical way to enforce its use is to give it with the tea, which should be done whenever possible. All water used by the men for drinking should be boiled, for which

purpose apparatus should be supplied. Water may be considered safe if boiled for thirty minutes, not counting the time consumed in bringing it to the boiling-point. Boiled water should not be kept for more than twenty-four hours and must be kept as prescribed in paragraph 172, Interior Economy, in clean receptacles, which must be frequently washed, must be supplied with metal faucets, and tightly covered. The taste of boiled water may be improved by adding citric acid."

The wells I saw were supplied with windlass and bucket, and many of them were under guard.

The Russian peasant is accustomed to a simple life, and the life of the Russian soldier, itself simple enough, is a promotion

Fig. 5.—Russian tent.

to him. I had it from the Emperor's own lips that his soldiers in Manchuria were better fed than his peasants at home.

The soldier's material wants were well met, and he had little or nothing with which to obtain other than that which his government gave him.

In the Far East everything was under absolute military control; nothing could be brought into the country except by military authority; and consequently little got there in the way of food or drink that could harm the soldier, even had he the wherewithal to purchase it. I observed some stores where many necessaries and a few luxuries could be purchased at little more than home prices. These were branches of army co-operative stores in St.

Petersburg and Moscow. Cigars and wine in moderation were obtained by officers; but the enlisted man's choice was very limited —tobacco, some sweet crackers, needles, thread, etc. I mention this to show that the Russian soldier was not subjected to the evil influences of the pie and beer vendor, not to speak of viler stuff, and his intestinal tract was not thereby rendered inviting to the microbes which are always seeking to destroy him.

I cannot but feel that the Russian authorities placed too much stress on one of a number of causes of typhoid epidemics, and lost sight of others of equal, indeed greater, importance in camp typhoid. I am told that the Japanese isolated their cases of typhoid as strictly as those of small-pox, and who can question their wisdom in so doing? I know not what their typhoid statistics may be, but I am very sure that if isolation was strictly practised the figures will be comparatively insignificant.

I do not think the necessity for isolation was fully appreciated by the Russians. They certainly sent the typhoid cases out of their camps in large numbers, but I was unable to learn of any extraordinary effort having been made to search out and isolate suspected cases, which is an important part of prophylaxis. Let us not forget, however, that the Russians were, at the time this epidemic appeared, thinking more of the enemy in front of them than that in their midst.

The conditions obtaining in at least some of the hospitals I inspected strongly impressed me with the opinion that the dangerously infectious character of the disease in its epidemic form was not appreciated by the hospital authorities. I have only a note here and there of the cases of hospital infection, but they occur frequently enough to indicate that such was rife.

The chief of the Red Cross at——told me that the type of the disease was severer in 1905 than in 1904; that a Red Cross physician and nurse had died during the preceding week, and that several others were critically ill.

I find the following note (August 25, 1905) illustrative of the hospital condition:

"This afternoon I visited the —— Red Cross hospital No 2, where there are 120 typhoid cases under treatment, with two or three deaths daily. The typhoid and other cases are treated in

the same wards, practically, as broad doorways connect all the wards and the doors are constantly open. The windows are without screens, the beds without bars, and the flies go as they list. The dejecta are received into bedpans that contain no disinfectant, are covered with a solution of calcium chloride, and at once thrown into a privy vault, which is the receptacle of all the kitchen and other wastes from the hospital, and which vault is emptied by Chinese labor once weekly. I had a long talk with the head nurse, and told her about the dangers of the disease she was treating, regarding which she seemed ignorant, though anxious to learn. The well from which was drawn the water used in the hospitals is about fifty feet from the latrine above

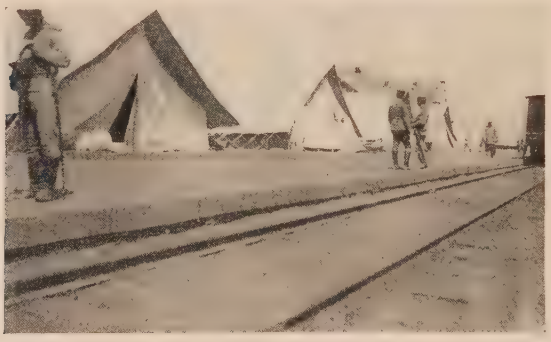

FIG. 6

described. In this hospital several of the *personnel* came down with typhoid fever. Apparently no precautions are taken to disinfect linen, dishes, hands, etc."

I later visited Military Hospital No. ——, contiguous to the above-mentioned Red Cross hospital. Here one of the physicians told me that the dejecta are received into a dry bedpan, are disinfected in the pan, and thereafter placed in a large receptacle filled with disinfectant, and there remain for twelve hours. He further told me that all the *personnel* are required to disinfect the hands after handling patients or infected material, which material also was disinfected. In proof of his statement, he showed me his finger-nails, which were discolored, presumably by the dis-

infectant. I did not personally see the above-described routine. In the physician's opinion, the hospital well was infected (though this had not been demonstrated bacteriologically), as the latrines were on higher ground, and seepage therefrom into the well probable. He added that he had no doubt the whole place was thoroughly infected, as last year (1904) the buildings were occupied by Military Hospital No. ——, which was used as a typhoid hospital. Ten of the *personnel* had been taken with the disease —five in one week. I observed that the windows were screened but the doors were hospitably open to the flies, and that patients were not protected by bed-nets. It was stated that attempts

FIG. 7.—The Russian camp latrine, or sink, is quite different from those used in other armies, and opens wide its hospitable arms during the typhoid season to the swarms of visiting flies. Some of the different types I saw are shown in the accompanying photographs.

had been made to protect the patients through the use of veils made from gauze, but they threw them off. Upon the whole, I am impressed with the conviction that any effort made in the hospitals to prevent the spread of typhoid infection was, to say the least, inadequate.

A study of the health conditions at Vladivostock are interesting. This fortress, located at the seaport of the same name, is considerably south and east of Harbin, though in eastern Siberia. The port is of some importance, and there is a civil population of about twenty thousand at present. The strength of the garrison was, in 1904, 19,378; in 1905, 66,000, with outlying forces numbering about 35,000 additional.

The movement of sickness was as follows:

	1904. Cases.	1904. Deaths.	1905 to Sept. Cases.	1905 to Sept. Deaths.
Typhoid fever	132	22	68	4
Scurvy	3	....	425	
Dysentery	7	....	36	3
Grippe	223	....	422	
Syphilis	128	....	215	
Other venereal diseases	342	....	(?)	
Enteritis	204	....	663	
Diseases of lungs and throat, acute	417	21	560	6
Accidents and injuries	165	2	321	2
Diseases of the eye	61	....	327	
Diseases of the skin	533	....	(?)	
Other diseases	1754	19	4070	28
Total	3970	64	7107	43

Average strength of commands (not including sailors):

	1904.	1905 to Sept.
Officers	378	(?)
Men	19,000	66,000

The water of Vladivostock is bad. There are no water-works, nor is there a sewer system.

During 1904 the following cases were treated in the —— Hospital, Vladivostock:

Typhoid fever	3
Malarial fever	14
Small-pox	1
Venereal	497
Pneumonia	19
Insanity	4
Tuberculosis	23
Wounds	151

Among these were eighty deaths. I was not given the statistics for 1905. In passing through the hospital I saw a number of cases of typhoid fever scattered throughout the various medical wards, mixed in with other cases. The surgeon told me that they were convalescents. The cases certainly must have been mild, as the cards indicated not over three weeks in hospital. I was informed that all cases are confirmed by bacteriological tests. The administration of this hospital was otherwise excellent, and yet here were typhoid cases treated alongside of other diseases, as though contagion was the last thing to be avoided.

As a practical fact, I do not think that the Russians have yet come to realize that camp typhoid fever is a quarantinable disease.

In glancing over the foregoing somewhat disconnected story, one is impressed with the fact that the troops in camp on the lines were sufferers from typhoid. It cannot be said that there was overcrowding. The positions covered a front of more than fifty miles, and, while they were occupied by over seven hundred thousand men, the camps were not continuous, but the troops were camped by regiment or even battalion. I did not, of course, see all the camps, or even the larger part of them; but those that I did see were certainly not overcrowded; there was, as a rule,

FIG. 8.—Camp latrine.

ample space within the unit camps, and ample surrounding space for organizations.

The men went into camp in May, after a winter in dugouts, following a series of terrific battles, and with none too much food; indeed, it has already been stated that the scorbutic taint prevailed extensively. The question naturally arises as to whether these were the men attacked by typhoid; or were the late-comers the victims? So far as I could learn by inquiry of those with whom I could speak, the men longest on the ground were those first attacked, but not when they came out of winter quarters and presumably were most debilitated; not during the cold of the spring, but during August, three months later. As Dr. Gorbacevich said, during this time they were working in the trenches,

but typhoid remained at its minimum until July, when it began to increase. There were two universal conditions in July which had not before obtained during the year—rain and flies. According to Dr.——, the camp conservancy had not been good, and the surface of the ground surrounding the camps—including the camp wells—was probably infected. We know that dejecta were scattered about on the surface, and we also know that there was some typhoid and some bacillary dysentery among the men. There was, however, no marked increase in the average number of dysentery cases. Regarding the use of raw water, the regulations seem to be specific enough, but, I fancy, were difficult to enforce.

The water, some of it, was analyzed, for every medical chief of a corps had a hygienist and laboratory attached to his staff, and besides these there were three laboratories at Harbin and one at Gungalin, not counting the Botkin railroad laboratories. The director of the latter told me that he had made thirty water analyses from samples taken about Harbin, as the result of which five wells were condemned and filled up, colon bacilli having been demonstrated. I got no such definite statement from other laboratories. Dr. Shäffer, of the German army, said, so far as he had observed, the soldiers drank when thirsty the water most convenient to get. Moreover, during the warmer weather they drank more than usual. It is a fair presumption that in Manchuria all running water is typhoid-infected, as typhoid is endemic there. So much for this possible cause of the typhoid epidemic. It has been heretofore stated that the common house-fly made its appearance in July, in swarms, and continued until frost came. The sinks were convenient; the fly, ubiquitous. How considerable a factor was the fly in this typhoid epidemic? Then, too, during the rainy season the men lived in the mud; they could neither keep themselves, their habitations, nor their camp-grounds clean. Were they factors in spreading the epidemic? If the typhoid bacillus was spread by these means, then why not the Shiga bacillus?

I quote from my notes of September 13, 1905, made while *en route* to Vladivostock: "Speaking of the typhoid epidemic, which is likely to spoil the splendid health record of the Russian

army, I am impressed with the belief that the following factors enter into it:

"1. The endemicity of the disease in Manchuria and in the army, many cases occurring every month.

"2. The depreciation of the health of the army during the winter in sod houses, the result of which was a marked scorbutic taint.

"3. The long continuance in the same camps.

"4. The rainy season, which began July 10th and continued through August.

"5. The appearance of flies, which occurred in June."

All the conditions, except the second, are identical with those which appeared in our camps during the Spanish-American War. The advantage with the Russians was that they could get no food other than that issued to them, and no stimulant other than tea.

The epidemic of typhoid in 1905 attacked probably one per cent. of the fighting army, say seven thousand, for most of the cases came from the front. Of this, probably 12 per cent. died, as the infection was more severe in 1905 than in 1904—say eight hundred and forty men. This is about the same number of cases as were reported in Philadelphia in 1904. Can a field army do better? I think so; but there will have to be a wider dissemination of a knowledge of the laws of right living before the white man will do it.

I learned nothing new regarding the treatment of typhoid. The same routine of sponging, diet, and watchful care. There were few facilities for tubbing. Soup, always acceptable to the Russian, was the diet, no milk being available; and those who desired it were permitted to eat bread. I heard of no operations for perforation, though frequently asked if such had been done. When I left Manchuria the time had not yet arrived for compiling the detailed statistics of the epidemic, and what is noted here is from the point of view of a hygienist rather than of a clinician.

DYSENTERY.

Dysentery has always been recognized as one of the most important causes of non-effectiveness in field armies. It was a veritable scourge to the Russian forces in China during the Boxer

uprising. Dr. Gorbacevich told me that the mortality from this disease in that campaign was 16 per cent. of the cases, whereas during the present war it is less than 5 per cent. The Union army lost from dysentery during the Civil War 24.77 per thousand —nearly twice the number dead from typhoid fever. Keen, quoting from the *Medical and Surgical History of the War*, says: "These disorders (dysentery and diarrhœa) occurred with more frequency and produced more sickness and mortality than any other disease. They made their appearance at the very beginning of the war, not infrequently prevailing in new regiments before their organization was complete, and although, as a rule, comparatively mild at first, were not long in acquiring a formidable character. Soon no army could move without leaving behind it a host of the victims. They crowded the ambulance trains, the railroad cars, the steamboats. In the general hospitals they were often more numerous than the sick from all other diseases, and rivaled the wounded in multitude."

Even as comparatively recently as the publication of this remarkable work, 1879, there was but a glimmering of the true cause of this scourge of armies. Lieutenant-Colonel J. J. Woodward, medical department, United States army, its distinguished author, in summing up his classical consideration of the causation of dysentery, says: "For myself, I strongly incline to adopt the view of the contagion of the stools for a certain class of dysenteric cases, yet I frankly admit the recorded evidence on this head is by no means so conclusive as that which we possess with regard to typhoid fever."

We now know that dysentery in its various forms is produced by definite organisms and is infectious. The history of the numberless epidemics in armies, reports of which have been made as far back even as the time of Herodotus, all point to this essential fact, and yet it was not until 1888 that Chantemesse and Widal first described the bacillus of dysentery, and not until 1898 that Shiga, a Japanese scientist, proved conclusively that the bacillus which bears his name is the true cause of epidemic dysentery.

There is, to be sure, a so-called tropical dysentery, due to amœba, but of this no case was found among the Russians in Manchuria, and it need not be considered here.

As the *contagium* of dysentery is contained in the dejecta of the sick, and, like that of typhoid fever and cholera, must be eaten or drank—in other words, taken into the intestinal tract—to produce the disease, the conditions under which dysentery becomes epidemic in armies are practically identical with those of typhoid fever; moreover, epidemics of dysentery usually occur during the late summer and autumn, coincidentally with those of the typhoid and fly seasons.

As to causation, some authors entertain the opinion that water is a less important factor in the spread of the Shiga (dysentery) than of the Eberth (typhoid) bacillus. This view was undoubtedly entertained by the Russian army physicians, who, it will be recalled, attributed the typhoid in their armies to water-infection, and the dysentery to fly-infection.

As a practical fact, however, the obtainable statistics show but 5456 cases of dysentery for the period of the war ending July 1, 1905, of which 256 died. On August 1st, one report shows 418 cases and another 677, with 181 cases of pseudo-dysentery. At no time did the number of cases reach beyond about half the number of typhoid cases, and the mortality was less than half the rate for typhoid fever.

It is interesting to speculate as to why the two diseases did not increase proportionately, since the conditions were so favorable to propagation, with this possible difference, that dysentery is not a water-borne disease, or, at least, water plays a minor role in its distribution.

I find by reference to my notes regarding Military Hospital No.——, Harbin, assigned as the contagious disease hospital, the following, under date of August 3, 1905: "There are to-day under treatment 35 cases of typhoid, 135 dysentery epidemica, 2 varioloid, 1 diphtheria, and 23 erysipelas. A considerable number of cases of typhoid have been treated in this hospital during the last sixteen months, with a mortality of from five to six per cent.

"For the last four months a dysentery (Shiga) serum, manufactured at the government laboratory, St. Petersburg, is being used with most satisfactory results, so the surgeon states. It was used in two hundred cases received since May last, among which

but three deaths occurred, the average mortality, the surgeon said, being four per cent. The dose is from ten to one hundred grams hypodermically. Four injections may be given daily, the total amount not to exceed one hundred grams. The serum should be kept in a cool, dry place, and is efficient for a year. I obtained a sample of it.

"There is an excellent laboratory at this hospital, under charge of a professor from the University of Tomsk, which seems to be a working institution. I was told that all cases of typhoid were proved by the Widal test. No amœba have been found in the stools of any of the dysentery cases."

Except for the serum, the usual routine of treatment was observed in the dysentery cases. Regarding the serum treatment, I have not sufficient *data* to base a conclusion, but it certainly seems most promising, and will bear further investigation, nay, demands it, so far as we are concerned, for, thus far, our experience with dysentery has not been happy.

From Keen's table I learn that during the four years of the Civil War we had an annual average of 735.96 cases per thousand of diarrhœa and dysentery, with a death-rate of 22.91, and Colonel Woodward writes in the medical and surgical history of that war that "these disorders occurred with more frequency and produced more sickness and mortality than any other form of disease."

In the list of diseases given at the beginning of this chapter it will be observed that epidemic influenza looms up somewhat prominently. I have no doubt of the existence of this disease in Manchuria, for I had an opportunity to observe several cases of it on the attaché's train. I am quite sure that the diagnosis was often a tentative one, for I was told in the hospitals that not infrequently cases admitted with this diagnosis subsequently developed well-marked typhoid symptoms. Both typhus and relapsing fever cases were constantly present with the army, though in small numbers. Of the former there were 201 cases up to July 1, 1905, with a mortality of 35; of the latter, 170 cases, of which 11 died. I saw some of these cases in the quarantine hospitals.

Small-pox cut very little figure in the mortality tables—209 cases, of which 12 died. All men who join the Russian army are vaccinated, and this is repeated before starting on a campaign,

and thereafter whenever necessary, so there was no reason to expect a severe manifestation of the disease, even though it is endemic among the natives of Manchuria.

The 1180 cases of scurvy with ten deaths probably represented but a small proportion of those more or less affected by the scorbutic taint. I learned from many sources that scurvy modified the course of both medical and surgical cases, and I have actually seen cases of typhoid fever with well-marked scorbutic symptoms.

Anthrax was always present in the army. This was accounted for by the Russian physicians on the hypothesis that the infection came from the sheepskin lining of the overcoats. Anthrax was epizootic in Siberia, and might easily have reached the army through the sheep which were brought from there by the thousand. These cases were treated antiseptically, but all surgical procedure was avoided.

The remarkable absence of mumps and measles will be noted.

I have no record of the total number of cases of pulmonary and cardiac diseases.

The statistics of venereal diseases from the beginning of the war to September 1, 1905, are as follows:

	1904	1905
Syphilis	2867	1600
Gonorrhœa and chancroid	5756	3276

The statistical officer estimated that gonorrhœa was to chancroid as 2 is to 1.

The total number of insane was 1081, of which 244 were officers.

I heard of no cases of beriberi among the Russians.

The foregoing *resume* of the morbific conditions and results among the Russians in the Far East, so far as at present known, should afford a lively satisfaction to those interested in the welfare of the soldier, both from a humanitarian and a militant standpoint. Russia, to be sure, had the advantage of the example of our sanitary errors, followed by those of the British in South Africa, and there was no reason why her soldiers and physicians should not have been fully alive to the importance of military sanitation. Then, too, the people of Russia were stimulated by the widely heralded sanitary work of their adversaries, and spared no effort to produce equally good results in their own armies.

Truly, the war in the Far East has taught us many valuable lessons, but none is more valuable than the sanitary lesson of that conflict.

So extended a discussion here of the morbific circumstances of the campaign in the Far East is only justified by the lessons we may derive from them, and which we, you and I, as military surgeons, may any day be called upon to apply in behalf of our own soldiers.

The traumatic circumstances, the purely surgical conditions, of the campaign would naturally be of great personal interest to the members of this society, and at the risk of further trespassing upon your time and patience I will invite your attention to a few salient features.

The extraordinarily large number of wounded and great mortality from artillery fire cannot fail to attract attention to the development of this arm. Over 20 per cent. of the killed and wounded are chargeable to artillery; more than twice that recorded by the Germans in the war of 1870.

The somewhat sensational reports sent from Manchuria regarding the terrific hand-to-hand fighting would lead to the inference that wounds from "cold steel" must cut no small figure in the casualty tables. As a matter of fact such wounds are practically negligible, less than a total of two thousand being reported by the Rusians.

So far as it is possible to compare the losses of the two contestants from *data* now available, which are yet incomplete, and consequently unreliable, it appears that, proportionately to the total casualties, the Japanese wounded exceeded the Russian by 12 per cent., while, on the other hand, the Japanese killed were 14 per cent. less than the Russian.

The fact, if it be a fact, that 33 per cent. more Japanese wounded died in hospital than did wounded Russians might indicate that the most severely injured among the latter, through the exigencies of war, were, perforce, left to die on the field of battle, while the Japanese were able to get practically all of their wounded to hospitals. The latter reported only about eight thousand "missing," while, as previously stated, the Russians had nearly forty thousand.

I am yet uncertain whether or not there are new lessons for us to

learn from this war regarding the stopping effects of the small-caliber, high-powered projectile.

Is it possible that the 7.60 mm. cupronickel-jacketed bullet of the Russians, which weighs 13.7 grams and has an initial velocity of 640 m. (mv.[2] 561), is more humane than the 6.50 mm. German-silver jacketed bullet of the Japanese, weighing 10.5 grams, with an initial velocity of 725 m. (mv.[2] 522)? This can apparently be answered in the affirmative, if to kill is considered more humane than to wound, but cannot now be answered conclusively.

A chief operating surgeon, writing from Liao-Yang, May 31, 1904, where "most of the wounded passed through my (his) hands," says: "The experience here convinced me that the Japanese rifles are better than ours. The range of this weapon is very great. Within 200 m., though the track of the bullet is small, the wounds were very fatal, owing to the explosive effects, there being extensive shattering of bone, or, in the abdomen, tearing of intestines. At longer ranges, 400 m.–800 m., the wounds were less serious. Except in abdominal lesions, the wounds inflicted by the Japanese rifle healed quickly. Even in abdominal cases with severe lacerations of the intestines, several patients recovered after suture of the intestines, where asepsis could be maintained. Wounds of the lungs were usually of a less serious nature, particularly those received at the higher ranges. Beyond 1000 m. the bullet disintegrated, and the wounds of entrance and exit were usually considerably larger than the channel made by the missile in its course through the tissues, and bones were seldom shattered." The same official is my authority for the statement that at the shortest ranges infection of the wound was infrequent, but at the higher ranges this was more often observed, due, he says, "to the foreign matter, especially clothing, driven into the wound." In concluding his report, he writes: "We can say that the Japanese bullet is modern and humane. About 32 per cent. of the wounded were returned to the fighting line inside of one month." Later, this authority wrote, on the subject of "humane" bullets, in a less optimistic frame of mind, as follows: "Fight only during the warm season, before frost; let the battle be on soft ground, free from stones or rocks, at ranges not less

than 250 m. See to it that the men go into the fight with empty bowels and bladder, and that there be no shooting at heads. If these conditions can be enforced, then the bullet so deadly today might prove humane." Dr. Wreden thinks that the modern jacketed bullet is, under certain conditions, more destructive than the old (large caliber) bullet, and that the lessened mortality among the wounded is wholly due to improved surgical technique. He says: "From the beginning of the war to January 1, 1905, only one amputation was required in every two hundred cases."

The statistics above quoted would indicate that the Japanese bullet is humane, as it was the chief factor in killing outright 29 per cent. of all Russians hit, and wounding 50 per cent. of whom but 4 per cent. died. To be killed outright is certainly more humane than to suffer long from painful and disabling wounds.

The shrapnel bullet is more than twice the caliber of the rifle-bullet and with but one-sixth its velocity; it is not jacketed, and when the projectile bursts, the shrapnel frequently deforms, assuming all sorts of shapes. While the shrapnel has no hydrodynamic effect, it inflicts severe wounds, with great destruction of both hard and soft tissues.

Of shrapnel, Colonel Havard writes: "These shells were much more numerous and did most of the execution." Of the Shimose shell he says: "It explodes with great noise on striking the ground, excavating a little crater, and giving off a small cloud of thick, brown smoke. Except when exploding within a short distance, it does but little mischief, for it breaks into a multitude of fragments, most of them minute and without much power of penetration."

Has the time yet arrived for us to draw anything more than very general conclusions from the surgical statistics of this war? I think not. I find, in looking over my notes, numerous entries which give some indications of the direction in which the experience will probably work out.

August 16, 1905. Dr. Brentano, of the German Red Cross hospital, said that altogether 600 cases of all kinds had been treated in his hospital. These included 127 surgical operations, of which

4 were amputations: 1 shoulder, tetanus, died; 1 thigh, lower third, shrapnel wound, infected, recovered; 1 arm, middle third, tetanus, died; 1 leg (Gritti operation), shrapnel wound, recovered. There were 3 resections, 2 of hip and 1 of wrist, all of which recovered. About 10 per cent. of the surgical cases died, as follows: 4 tetanus, 4 sepsis, 1 peritonitis, 2 meningitis, 1 empyæma, and 1 rupture of spleen. Only 1 cœliotomy was done, for gun-shot wound of abdomen with peritonitis; this resulted fatally. Four pelvic abscesses following gun-shot wound of abdomen were evacuated per rectum and recovered. No cases of bayonet or sabre wounds were received. Dr. Brentano further said that almost all cases of shell and shrapnel wounds arrived infected. In one case (non-infected) a shrapnel bullet penetrated the right lung and was removed from the back. Cases of gun-shot wounds from rifle-bullets were usually sterile.

Dr. Butts, in charge of a Red Cross hospital at Gotsiadan, furnished the following statistics: From 10 to 20 per cent. of all missiles lodged. 3 to 4 per cent. of bullets lodged. All shrapnel wounds were infected and but few bullet wounds. Of fifty cases of infected wounds of head operated upon, one-half died; of one hundred and fifty sterile cases 10 per cent. died. Dr. Butts is also of the opinion that rest and surgical non-interference are the indications in wounds of the abdomen; 50 per cent. of such cases died of peritonitis. He reports five cases of abdominal abscess following wounds, all of which recovered. Among 915 operations there were 75 amputations, 15 resections, 25 excisions, 3 aneurysms, 200 trepanations.

Dr. Butts treated 24 cases of gangrene, of which 23 died, and 3 cases of tetanus, all of which died.

Regarding the anatomical location of wounds, I have no *data* of sufficient extent to be of general value. I have heard it stated casually that the number of wounds of the head and right upper extremity was unusually large, due to the necessary exposure of these parts in the act of firing, but I have not regarded this as an authenticated statement.

From what I have been able to gather from conversation with Russian surgeons, I think it probable that we shall have no occasion to modify our views regarding the effects of high-powered bullets

at different ranges. Dr. Wreden writes: "The explosive effects of the Japanese bullet in spongy bone tissue is observed only at close range—100 m.—beyond which the destruction is slight, but in dense osseous tissue explosive effects are observed up to 800 m. Within 200 m., wounds of the cranium are generally fatal, the hydrodynamic effects being most marked, and within 100 m. the calvarium is greatly comminuted. Beyond 200 m., tangential wounds of the head are not usually fatal, but penetrating wounds are lethal up to 1000 m." Dr. Wreden regards wounds of the face and neck serious, and if the latter are complicated by injuries to arteries, trachea, or œsophagus, they are usually fatal. Colonel Havard reports a wound of the cervical region, in the case of Prince Murat, in which the bullet traversed the neck from side to side, coming out close to the internal carotid artery; and another case, in which the missile entered at the point of the chin and emerged close to the spine on the right side. Both of these cases were convalescing.

So far as I could ascertain, there is a general consensus of opinion that bullet wounds of the lungs were not serious.

The impression left on my mind is that cœliotomy for any purpose was a rare operation. This impression was gained, not from statistics—for such were not obtainable, except from a single hospital here and there—but from conversation with many surgeons. The only really definite statement I have on the subject is found in a report made by a chief operating surgeon, of which I will submit a free translation. "Among the most serious wounds we have encountered are those of the abdomen, in the treatment of which very little has been accomplished. We can only say that the more rest the patient can have from the very moment of the infliction of the wound, the better the result. The character of the missile—bullet, shrapnel, shell, or cold steel—is of great importance in determining the result, and lesions caused by each of these should be considered separately. The severity of wounds of the abdominal region caused by the modern bullet is directly proportionate to the range. As the result of the experience gained in several operations done for penetrating gun-shot wounds of the abdomen at close ranges, I was deeply impressed with the great explosive effect of the modern bullet. In some of the cases in

which the stomach was full, it was burst into pieces and entirely separated from the surrounding organs. A like result followed with a full bladder, and great havoc was wrought in liver, spleen, and kidneys. In such cases, as was to be expected, the symptoms of shock were pronounced and resembled those of internal hemorrhage. The wounded man almost invariably fell to the ground, complaining of intense pain in the belly, but did not lose consciousness. If left quiet, the pain subsides and the shock disappears." The report adds: "These cases never spoil the statistics of the rear hospitals, for they die on the field or at the dressing-station."

"Beyond 400 m. the explosive effects were not observed, and the patient did not at once fall. Soon, however, symptoms of shock supervened, with vomiting, especially in alcoholics, and the wounded man lay down. This condition usually continued for several days, and has led to early operative interference, which only resulted unfortunately."

The reporter estimated the mortality from rifle-bullet wounds of the abdomen at 40 per cent. of such cases. This was based upon nine months' experience in the Far East. Shrapnel wounds penetrating the abdomen were much more serious than bullet wounds, the mortality being 80 per cent.; when they involved the liver, spleen, or kidneys, they caused death quickly from extensive hemorrhage, and in the stomach, intestines, or bladder the shrapnel inflicted much severer wounds than the rifle bullet, even within the explosive ranges.

Wounds of the abdomen from ricochet bullets or shell splinters were usually so extensive that surgical interference, even under the best conditions, would probably have been ineffective. Such wounds were particularly observed among artillerymen. The external appearance of these wounds differed from those made by the ordinary bullet, the wound of entrance being considerably larger; moreover, the course of the bullet was much more irregular. Large pieces of shell sometimes caused immense destruction of tissues, with almost instant death, and yet such cases sometimes recovered.

I have a report on sabre, lance, and bayonet wounds which I will venture to quote: "The wounds from Cossack lances are large and of the most serious nature; for not only does the point

enter the body, but the entire weapon up to the handle. Such wounds are almost inevitably fatal, the wounded dying on the field or *en route* to the dressing-station."

In considering bayonet wounds, a word must be given to the weapon. The Russian bayonet is rapier-shaped. It is made for thrusting, not cutting, and it inflicts only punctured wounds, the edges of which quickly contract upon withdrawing the weapon.

The Japanese bayonet is a knife, long, strong, pointed, and sharp, and with it not only can punctured wounds be inflicted, but incised, contused, and lacerated wounds as well. Wounds of the abdomen caused by the Japanese bayonet were generally long gashes, through which the abdominal cavity was emptied of its contents, causing speedy death.

The chief operating surgeon above quoted, in summing up his conclusion as to battlefield injuries generally, said that to recommend the doing of laparotomy in a divisional mobile military hospital during the progress of battle, with a constant inflow of wounded, is unwise. "From among several evils, the least should be chosen, and time and strength are not available for such operations under such conditions. These abdominal cases should not be operated on, but should be given rest, temporary dressing, and morphine."

Finally, he said active surgical interference in abdominal cases depends upon the temporary location of the wounded, his condition, and upon the kind of weapon with which the wound was inflicted. The result of treatment depends upon the method adopted, and in all such cases absolute rest is essential for at least a week. Morphine is our sheet-anchor in all wounds of the abdomen.

I heard nothing but praise for the first-aid packet, which was carried by every officer and enlisted soldier. The officer usually attached the packet to the scabbard of his sword, thus insuring its constant presence, for a Russian officer is never without his sword.

The soldier was supposed to have a special pocket in the front of his breeches, on the right side, which was devoted to the first-aid packet, but, so far as I saw, this rule seemed more honored in

the breach than in the observance, though a place was always found for the packet somewhere.

The Russian first-aid packet was much like ours in general appearance and size. It contained 1 antiseptic bandage of sublimated gauze, 3 m.; 2 antiseptic compresses, sublimated gauze and cotton; 1 safety-pin.

These were hermetically sealed in a rubber (waterproof) cover, and the packet was thus issued for use at the dressing-stations, etc., but when issued to the men it had an additional cotton-drill cover, on which was printed a list of contents and the following directions:

"1. Take off the outer (cloth) cover.

"2. Open the (rubber) package, take out the compresses, and place on the wound—absolutely dry.

"3. Apply the antiseptic bandage over the compresses—but not too tight.

"4. Fasten the end of the bandage with the (safety) pin.

"*Notice.* In case of a perforating wound, place one of the compresses over each opening."

Of the practical use of the packet, a surgeon wrote that he was much impressed with the care shown in distributing the first-aid packet and the careful way they were carried by officers and men. The first-aid bandaging was readily done by the men, though not under strictly aseptic conditions; nevertheless, though the heat was great and flies plentiful, there was no sign of infection during the first twenty-four hours. The first-aid packet proved of invaluable service to the wounded during transportation. Dr. Wreden objected to the red dye in the gauze, which he thought occasioned a cutaneous inflammation, aggravated by heat and perspiration. But might not this have come from the sublimate itself? He suggested that the gauze should be soaked in a 5 to 10 per cent. solution of creosote, the especial advantage of which is that it would keep flies away from the dressing.

The first-aid packet has passed beyond the experimental stage, and is now universally recognized the world over as a legitimate part of the soldier's field equipment. It has both a positive and a negative value—positive because of its appropriateness, and negative because it prevents the use of an inappropriate dress-

ing, which would surely happen if a proper dressing was not available.

The consensus of opinion among Russian surgeons with whom I discussed the matter was that rifle-bullet wounds were usually sterile, and wounds from artillery projectiles usually infected. In summer there was much less wound infection than in winter. This is explained by the fact that the body and clothing were more frequently washed in summer than during the cold season, and that the clothing was lighter and less likely to harbor infection. I find this somewhat startling statement in a report to the Emperor, under date of April 15, 1905: "The last evacuation (Mukden) was carried on in excellent manner, being complicated only by the difficulty in healing the wounded, who suffered from blood-poisoning and gangrene, resulting from fur clothing and cold weather." A surgeon told me that after Mukden there were many cases of frost-bite, and there was also a peculiar anæmic condition with purpura, which some of the physicians thought was due to the cold which reduced the fibrinogen. I fancy they had not seen much scurvy in their practice up to that time. Another surgeon told me that after the battle of Sandipas a number of wounded were frozen to death as they lay on the ground.

I inquired of many surgeons if they had used or seen used any new or special method of treatment, but none had. Dr. Shäffer, of the German army, told me he had not infrequently observed the Russian surgeons painting the surface above wounds with tincture of iodine, but he did not learn the reason therefor.

I could get no exact information as to the percentage of infected wounds that came under treatment.

The surgeons at Irkoutsk told me that all the cases they received were infected. By the way, that reminds me I saw six cases of hip-joint amputation in one Red Cross hospital there. all of which were doing well.

Tetanus was not an infrequent complication of wounds. In the surgical clinic at Harbin, through which seven thousand patients had passed, there were twelve cases of tetanus, of which two recovered. The serum treatment was ineffective.

The statistical officer at Harbin reported that tetanus was in the proportion of less than two to each thousand of wounded,

Of the two hundred and fifty cases of tetanus, 87 per cent. died.

A surgeon said that his largest number of cases of tetanus occurred after Mukden. He got the best results from chloroform and chloral, but nothing from antitoxin.

Erysipelas was always present, and it totaled five cases per thousand of wounded.

I believe that the latest surgical procedures were employed in the hospitals in the Far East, though I saw a great many more surgical cases in the wards than in the operating-room.

Rubber gloves were not generally used; in fact, I think their routine use was only required in the German Red Cross hospital though I occasionally saw a pair in the Russian hospitals.

Silk was universally used for ligatures and sutures. The Russian surgeons were quite emphatic in their condemnation of animal ligatures in field service, and some of them told me they never used any other than silk ligatures under any circumstances, as there was no certainty of sterility in any other suitable material. Dr. Chervinsky told me that linen thread treated with celloidin was quite as good as silk, and much cheaper. So far as observed, the surgical armamentarium was good. In the beginning of the conflict there were obsolete instruments on hand, which, as with us, were thrown in to meet the emergency and quickly disappeared to be substituted by modern instruments. Regarding instruments, a Russian surgeon wrote: "I am sorry to say that I saw (May, 1904) many instruments with bone handles. There was a great shortage of artery forceps and hypodermic syringes. The recently introduced lamps proved of the greatest service, especially after Liao-Yang, where we worked three days and nights. This battle not only illustrated the advance made in surgery, but also the great improvement in weapons. We can figure one dead to three wounded."

I have not burdened this paper with an account of the many interesting surgical cases I saw in the Far East, but, so far as possible, have endeavored to deduce lessons for our own guidance from the general surgical experience of the war.

We learn therefrom that there is no occasion to modify the views heretofore held, that cœliotomy, or indeed any major operation,

on the field of battle is interdicted. In such cases, expectancy is the correct procedure, and rest and morphine the treatment. The suggestion that we should follow the rule of the ancient warriors, who went to battle in clean raiment and a clean body, is valuable. Add to these an empty stomach and bladder, and there is little left to be done but trust in Providence. If wounded, keep the wound clean and give nature a chance, at least until a permanent hospital is reached.

A YEAR'S EXPERIENCE IN INTESTINAL SURGERY.

By JOHN B. DEAVER, M.D.,
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The forty patients whose cases form the text of my remarks have been operated on at the German Hospital and the Children's Hospital of the Mary J. Drexel Home since January 1, 1905. These cases comprise twelve simple enteroenterostomies; eleven intestinal resections, with enteroenterostomy; one enterotomy; two colostomies; seven enterorrhaphies for various forms of fecal fistula; one suture of a typhoid perforation; one reduction by manipulation of an intussusception; and eight instances in which strangulating bands or adhesions were divided, besides three other (atypical) operations—a total of forty-six operations on forty patients.

There were thirteen cases of intestinal carcinoma, all in the large bowel. The cecum was dissected in four cases, the hepatic flexure of the colon in two, and there was one case each in which the part affected was the transverse colon, the splenic flexure of the colon, and the rectum; while there were four patients in whom the sigmoid was the seat of malignant disease. Five of these thirteen patients died—those patients in whom the splenic flexure and the rectum was involved, one of those with the cecum affected, and two of those in whom the sigmoid flexure was diseased. The remaining eight patients recovered from the primary operation, and were relieved temporarily; but of the four successful cases in which the patients were seen sufficiently early for a radical operation to be done, two developed symptoms of recurrence about eight months later, and were again temporarily relieved by further operation; and in the case of two others, on whom a radical operation was done, sufficient time has not elapsed since

the operation to permit of their being considered in this connection.

It is true of intestinal cancer, as of all other regions affected by malignant disease, that the surgeon seldom sees the patients early enough to be enabled to offer them hope of radical cure. Early recognition of internal cancer is one of the desiderata of surgery. Among the thirteen patients with internal carcinoma herewith reported, only six were seen early enough to render any radical operation justifiable, and in most of these cases, during the past, as during former years, I have been forced to content myself with doing an entero-anastomosis. When the cæcum is affected, I perform a lateral anastomosis by suture between the lower ileum and the transverse colon, and occlude the ileum by a ligature just distal to the anastomosis. It is, I believe, universally recognized as better to use the transverse than the ascending colon for the site of the anastomosis, as it is more movable, and as it has long been a recognized principle of intestinal surgery to unite movable to movable, and fixed to fixed parts of the alimentary canal. When the malignant growth affects the transverse colon or the upper part of the descending colon, an ileosigmoidostomy is the palliative operation to be preferred. In one patient with carcinoma of the upper rectum, or lower sigmoid, which could not be excised, I made an anastomosis by means of the Murphy button between the bowel above and that below the constriction—a sigmoidoproctostomy as it might be called. I employed the button because of the difficulty of suturing the gut in this position, and also to shorten the time of the operation. But in general I much prefer to use sutures alone.

In regard to the etiology of carcinoma of the cecum, I desire to call attention to the increasing frequency with which primary carcinoma is found in the appendix. Recently we have resumed microscopical study of all the appendices removed at the German Hospital, and Dr. Kelly has reported two cases of primary carcinoma of the appendix among the last one hundred and ninety-six examined, or in a little over 1 per cent. of the cases.

In the first patient herewith reported (Case 1) a man aged seventy years, the cecal growth appears to have originated in a traumatism received some two months before admission. In

the case of another patient (Case 2) a man aged thirty-three years, the appendix had been removed for symptoms of chronic inflammation less than two months before the resection of the cecum for carcinoma. Unfortunately, we had not then resumed the routine examination of every appendix, and the malignant growth, which was then presumably in its early stages, was not recognized, although it was noted that the cecum was injected and thickened. The value of routine microscopic study of appendices removed at operation is thus conclusively demonstrated.

There was one patient (Case 14), a woman aged seventy years, with chronic intestinal obstruction due to a stricture of the sigmoid. In view of her age, Littre's operation was done—the formation of an artificial anus in the left iliac region. She was in the hospital over seven weeks after the operation, gradually gaining strength, but died soon after returning to her home.

There were thirteen patients operated on for acute intestinal obstruction, exclusive of two cases of intussusception, to be referred to presently, and of cases of strangulated hernia, which are not considered at all in this series. In three cases of obstruction the bowel was gangrenous and necessitated resection. The first of these patients (Case 15), a woman, had also an irreducible femoral hernia. If this hernia, when first seen, had been inflamed from injudicious attempts to reduce it, as was the case in a patient I operated on some years ago (see *Appendicitis, its Diagnosis and Treatment*, third edition, Philadelphia, 1905, p. 429) for appendicitis, it might have complicated the diagnosis; but as it was, there was no doubt present that the obstruction was internal, and accordingly laparotomy was done. A small knuckle of ileum was found obstructed by a band and gangrenous; this portion of the bowel was therefore resected, and an end-to-end anastomosis of the intestine performed, the patient making a good recovery. The second patient (Case 16), also a woman, who had had fecal vomiting for two days and was in extremely poor condition when operated on, had gangrene of the ileum from adhesions to the right Fallopian tube. In this patient, also, resection and circular enterorrhaphy were performed; but she died the next day, never fully rallying from the operation. The third patient (Case 17), was a man who developed obstruction three weeks after an

operation for appendicitis complicated by diffuse peritonitis. His vitality was at a low ebb as a result of the previous peritonitis, and he succumbed soon after the operation for obstruction.

In connection with resection of the small bowel, there are several questions of interest which I do not think have ever been conclusively answered. One is whether lateral anastomosis is to be preferred to circular enterorrhaphy. For many years end-to-end anastomosis seemed to be the method of choice, the use of the Murphy button rendering the operation rapid and comparatively safe. Later, when surgeons became more expert with intestinal sutures, the end-to-end method acquired a bad reputation, as productive of strictures, and the button was thought to predispose to perforation. Accordingly the custom arose of closing the ends of the bowel and doing a lateral anastomosis. This method also has its drawbacks, the two chief to my mind being the time consumed and the interference with peristalsis caused by the longitudinal division of the circular fibers of the intestine. The unnatural deviation of the intestinal channel is also undesirable, and the blind pouches formed at each end of the apposed segment of bowel may become clogged with stagnating fecal matter. For my own part I much prefer the end-to-end method by means of sutures alone, and think that where due care is exercised, by oversewing or by knotting the suture in transit, to prevent purse-stringing or puckering of the line of sutures, no strictures need be feared. For the inexperienced or occasional operator, probably the use of the Murphy button, with end-to-end anastomosis, is preferable, but when such mechanical aid can be dispensed with, I think there can be no doubt that it is preferable to do so.

After resection of the large bowel, on the other hand, end-to-end anastomosis is distinctly inferior to lateral anastomosis, chiefly on account of the wide extraperitoneal area exposed between the layers of the mesocolon, which renders healing uncertain and fecal extravasation probable.

The other important question in connection with intestinal resection refers not to the method of restoring the continuity of the intestinal canal, but to whether continuity shall be restored at the primary operation, or whether it is better to first form a

fecal fistula. The choice certainly depends more upon the condition of the patient and upon the site of the resection than upon any preconceived theory as to the proper course in all patients. As far as the site of resection is concerned, the old rule still holds good, I think, that the higher up in the intestinal canal the lesion is situated, the more strenuous should be our endeavors to prevent the formation of a fecal fistula. In spite of the excellent results obtained by certain surgeons, by the method of carefully collecting the discharge from the proximal coil and of periodically injecting this discharge into the distal loop of bowel, I think no surgeon would court the formation of a fecal fistula in the upper intestinal tract. There remains the difficulty, however, of determining with accuracy the location of the lesion in the intestine; for I think all are agreed that intestinal localization, notwithstanding the studies of Monks, is not yet an exact science. And accordingly I always endeavor to restore the continuity of the intestinal canal at the primary operation, unless I am convinced that to do so would unnecessarily jeopardize the patient's chances of recovery. Being convinced, however, of the importance of intestinal toxæmia as a lethal factor in many of these patients, I make it a point to thoroughly empty the bowel on the proximal side of the obstruction, when distended, before concluding the operation.

In the second patient above referred to (Case 16), in whom resection of the gangrenous ileum was done, care was taken to empty the distended bowel, about two quarts of liquid feces being evacuated. In another patient (Case 23) a child, who was pulseless and blue at the time of the operation, which was done under local anesthesia (under cocaine), Dr. H. C. Deaver resorted to the old-fashioned operation of enterotomy—Nélaton's operation—opening a distended coil of intestine, after relieving the only constriction to be found, and then stitching the bowel into the wound. The intestinal canal was immediately relieved of several ounces of fluid and the boy made a satisfactory recovery. The fecal fistula was subsequently cured by an intestinal resection with end-to-end anastomosis. In still another patient (Case 21), in whom the obstruction was found to be due to a kink in the upper jejunum, a rectal tube was passed up through the colon, and by means of manipulation of the intestines exposed through the

abdominal incision nearly two pints of liquid were evacuated from the bowel. This boy likewise made a satisfactory recovery. In Case 18, also, recovery followed gentle manipulation of the distended bowel, urging its contents downward into the contracted intestine, after an adhesion had been released.

By such means as these it is often possible to avoid the formal institution of a fecal fistula; but I venture to think that there will always remain a certain class of apparently moribund patients in whom resort to Nélaton's operation of enterotomy will be not only justifiable but even imperative.

There were nine patients in this series with some form of fecal fistula. A patient (Case 28) with enterovaginal fistula developed this condition soon after the operation of panhysterectomy for carcinoma of the uterus. She returned about a month later to have the fecal fistula repaired. This was done by opening the abdomen, releasing the ileum where it was adherent to the vagina, about six feet from the ileocæcal valve, and suturing the perforation. After this operation a vesicovaginal fistula formed, but finally closed spontaneously, rather contrary to expectation, as both fistulæ were an evidence of the lack of reparative power present in this patient.

There were eight cases of external fecal fistula. In three instances this condition was the result of appendicitis; in two the result of strangulated inguinal hernia; in one the result of the operation of enterotomy; the fistulæ in the two remaining instances being in the sigmoid and following some pelvic lesion in women (Cases 29 and 34). The fistulæ in the sigmoid were easily repaired by suture, and recovery in both cases was uneventful. Two of the patients with fistulæ following appendicitis recovered after removal of the appendix and suture of the defect in the cecum, but the third patient (Case 30) was discharged unimproved after various unsuccessful efforts had been made to permanently close the fecal fistula. Two patients (Cases 31 and 33) had been operated on a year previously elsewhere for strangulated inguinal hernia. The bowel had been gangrenous and in each case a resection and an end-to-end anastomosis had been done. The fecal fistula which resulted in these patients was successfully repaired by a further resection with end-to-end anastomosis.

The same procedure was successful in the case of the patient previously operated on by enterotomy.

The treatment of fecal fistula remains one of the departments of surgery which exercise in the highest degree a surgeon's judgment, patience, and skill. A fecal fistula is sometimes established by the surgeon himself for some purpose or other. It has been urged that when this is done the two loops of bowel should be sutured side-by-side into the wound, so that they lie together like the barrels of a gun, and so that the continuity of their lumen can be ultimately restored by some form of enterotome without again opening the peritoneal cavity. In my own opinion this is an injudicious course to pursue. When the surgeon desires to make a fecal fistula I think it much better merely to suture the convexity of the gut to the parietal peritoneum, and then the lumen will frequently be restored spontaneously. The more healthy the bowel is, the less dangerous and troublesome will a formal operation be for its repair, if any such operation be eventually required; and the only results to be derived from the use of the enterotome in these cases are more satisfactorily accomplished by a formal operation. In patients where the bowels are more or less extensively diseased, and where any formal operation is likely to be extensive and serious, it is, on the other hand, impossible to use the enterotome, since the afferent and efferent loops are not parallel, nor are the neighboring serous coats of the intestine in a condition to permit of ready adhesion by prolonged contact. It is such cases as these that necessitate extensive resections to procure normal serous surfaces which will render possible a plastic operation for the restoration of the continuity of the intestinal canal.

There were in this series two adults with intussusception, of the ileocolic variety in both instances. In the first patient (Case 36), operated upon by one of my assistants, Dr. Ross, the intussusception was irreducible, and an ileocolostomy was done. The patient, however, died two days later of stercoremia (?). The other patient (Case 37) developed symptoms of intestinal obstruction during the course of typhoid fever, and the diagnosis of intussusception was made chiefly from the existence of tenesmus, and from the mucus passed by rectum. The operation was done so soon after the development of the symptoms that the intus-

susception was readily reduced by manipulation, and the patient made an uneventful recovery, the course of the typhoid seeming actually shortened by the operation.

Another patient (Case 39) with typhoid fever, who presented symptoms of peritoneal involvement, was also promptly operated upon. In this case the œdematous, acutely inflamed appendix was removed, and a small perforation of the lower ileum, which was exuding fecal matter, was sutured. No irrigation was employed and drainage was established by means of a glass tube to the pelvis. Recovery was uneventful.

In one patient (Case 40), a man aged thirty-six years, there was a history of ulcerative colitis, lasting for two and a half years. At the operation the lumen of the transverse colon was found to be entirely occluded by firm masses of feces, and the descending colon and the sigmoid flexure contained large amounts of scybalous feces. The walls of the colon throughout its extent were thickened and diseased. The cæcum was opened, with the intention of making an artificial anus in the right iliac region; but the walls of the bowel were so extensively diseased that the safer course seemed to be to unite the healthy ileum to the comparatively normal sigmoid. An ileosigmoidostomy was therefore done, but the patient died four days later; and the autopsy showed the site of the anastomosis to be gangrenous, the sutures sloughing out. Possibly the formation of an artificial anus, as at first intended, would have further prolonged this patient's life; but the whole colon was found so irretrievably diseased postmortem, that any radical cure would have been out of the question.

A short abstract of the cases considered is appended:

LIST OF CASES REPORTED.

1. *Carcinoma of Cecum.* G., aged seventy years, male, struck in right iliac region two months before operation. Operation, January 21, 1905. Ileocolostomy. Recovered and discharged February 10, 1905.

2. *Carcinoma of Cecum.* S., aged thirty-two years, male. Appendix removed for chronic disease February 21, 1905. Cecum at that time injected and thickened. Operation, April 6, 1905.

Resection of lower ileum, cecum, and part of ascending colon; ends of bowel closed, and ileocolostomy done by lateral anastomosis to transverse colon. Glass tube drain. Fecal fistula on April 9. Fistula closed spontaneously on April 19. Recovered. Bowels acted well. Discharged in good health April 28, 1905. In a few months developed continuous pain and severe abdominal cramps. Became emaciated and sallow. On December 26, 1905, abdomen reopened, anastomosis between ileum and transverse colon found patulous, but distorted by indurated retroperitoneal tumor. Mesenteric glands involved. Ileosigmoidostomy done. Discharged January 18, 1906, symptoms relieved.

3. *Carcinoma of Cecum.* M., aged thirty-seven years, female. History negative. Operation, June 22, 1905, ileocolostomy. Recovered, and discharged July 6, 1905.

4. *Carcinoma of Cecum.* E., aged thirty-nine years, female. Appendix and both ovaries removed elsewhere nine years ago. Left breast excised for carcinoma, four years ago. Recurrence in scar excised, three years ago. Has had abdominal pain for nine years, ever since first (abdominal) operation. Has had attacks of shooting pain and diarrhœa. Examined by her physician one week ago, and advised to have operation for palpable abdominal tumor. Operation, February 10, 1906. Carcinoma of cæcum, excision 15 cm. of ileum, cæcum, and 7.5 cm. of ascending colon. Ends of bowel closed, and ileosigmoidostomy done by lateral anastomosis. Did well, but died suddenly February 21, 1906, of acute dilatation of heart, eleven days after operation.

5. *Carcinoma of Hepatic Flexure of Colon.* R., aged forty-nine years, male. General abdominal pain and distention nine months before operation. Abdominal discomfort with diarrhœa commenced eight months before operation; later attacks of pain have been accompanied by constipation. Frequently vomits. Has lost flesh and strength. Operation, June, 1905. Circular carcinoma of hepatic flexure of colon, no involvement of surrounding glands. Excision of growth, including parts of ascending and transverse colon. End-to-end anastomosis with needle and thread. Recovery. Took Alexander treatment for malignancy. Patient remained well for eight months, when symptoms of chronic obstruction returned. The abdomen was reopened February 12,

1906, adhesions of small intestine liberated, and evidence of recurrence found at site of excision. Lower ileum anastomosed (lateral) with transverse colon, and distal part of ileum tied off immediately below anastomosis. Recovered, and discharged, March 5, 1906.

6. *Carcinoma of Hepatic Flexure of Colon.* O., aged twenty-nine years. Had been operated on for appendicitis. Since January, 1906, has experienced a dull aching pain beneath right costal margin. Has had attacks of sudden, sharp pain, accompanied by vomiting and profuse sweating, and followed by collapse. Has had a mild degree of jaundice. Never passed a biliary calculus. Stools light clay color, bowels costive. A firm, tender mass can be felt in right hypochondrium, apparently continuous with liver dulness; moves in respiration; extends one finger's breadth below umbilicus. Operation, May 21, 1906. Large carcinomatous mass of hepatic flexure of colon, surrounded by inflammatory exudate and pus, gall-bladder being involved in the adhesions. The glands of the right free border of the lesser omentum, the cystic and common ducts greatly enlarged. Excision of cecum, ascending and part of transverse colon. Ends of bowel closed, and lateral anastomosis done between ileum and transverse colon. Recovered.

7. *Carcinoma of Transverse Colon.* T., aged fifty years, female. Intermittent abdominal pain for two years, with anorexia, nausea, vomiting, and constipation. Has been passing mucus for two months. Operation, April 13, 1905, ileosigmoidostomy. Recovered and discharged, May 2, 1905.

8. *Carcinoma of Splenic Flexure of Colon.* B., aged thirty-six years, female. Always constipated, markedly so for three months. Always vomited when bowels had not moved for a long time. Chronic intestinal obstruction. Operation, September 27, 1905, ileosigmoidostomy. A malignant stricture was found at splenic flexure. Hemorrhage from bowel began seven hours after operation and continued until death. At autopsy, anastomosis found perfect, but a perforation further up in colon, apparently traumatic.

9. *Carcinoma of Sigmoid Flexure of Colon.* McD., aged forty-nine years, male. Scybalous masses for three months, with obstinate constipation. Intestinal obstruction for three days

before operation. Operation, April 10, 1905, sigmoidoproctostomy with Murphy button. Died April 17, 1905.

10. *Carcinoma of Sigmoid Flexure of Colon.* S., aged sixty-nine years, female. Two years before operation patient suffered from uncomfortable sensations, gnawing feeling, clothes feeling too tight around waist; this lasted for six months, when abdomen began to swell slightly. Nausea in morning and after eating; some vesical irritation; bowels irregular; vomited three or four times a day. Small stools. Has lost no weight. Examination shows sensitive point to inner side of left anterior superior iliac spine, corresponding to position of sigmoid. Sigmoid palpable, also a small mass apparently in wall of sigmoid. Operation, January 10, 1906. Sigmoid exposed by incision through left rectus muscle; delivered and found to contain small carcinomatous mass, size of finger-nail. Mass excised, ends of the sigmoid sutured, and a lateral anastomosis done between ileum and sigmoid below site of excision. Recovered, diarrhœa lasting for three weeks after operation. Discharged, February 6, 1906.

11. *Carcinoma of Sigmoid Flexure of Colon and Left Broad Ligament.* K., aged thirty-four years, female. Typhoid fever twelve weeks before operation, being in bed five weeks. During this illness first noticed pain in lower left abdomen. At first pain was shooting, later became dull aching in character. Tender over right iliac fossa. Has had profuse and very foul-smelling leucorrhœa since beginning of trouble in lower abdomen. Has dragging pains in back. No difficulty in urination. No more constipated than before present trouble was noticed. Vaginal and abdominal examination reveal a large mass on left side of uterus, apparently fixed to uterus. Operation, May 16, 1906, showed a mass involving left broad ligament and sigmoid flexure. It was deemed inadvisable to attempt its extirpation, so an ileo-sigmoidostomy was done, uniting the terminal portion of the ileum to the lowest part of the sigmoid flexure by lateral anastomosis. Uneventful recovery followed.

12. *Carcinoma of Sigmoid Flexure of Colon.* C., female. Operation of ileosigmoidostomy done March 31, 1906. Died April 5, 1906.

13. *Carcinoma of Rectum.* M., aged sixty-three years, female. Obstinate constipation for six months. Operation June 1, 1905.

Left iliac colostomy, bowel being opened by cautery three days later. Died (pulmonary embolism) June 9, 1905.

14. *Benign Stricture of Sigmoid Flexure of Colon.* H., aged seventy years, female. Admitted for intestinal obstruction. Operated same day, May 25, 1905. Left iliac colostomy. Developed abscess in right iliac fossa, which was opened June 16. On July 6, impacted feces were removed from rectum under nitrous oxide anesthesia. Recovered, and discharged July 16, 1905, with artificial anus in good condition, and occasional movements from rectum. Died of asthenia shortly after discharge.

15. *Acute Intestinal Obstruction.* B., aged thirty-eight years, female. Has irreducible right femoral hernia, not sensitive, not inflamed. Pain in right lower abdomen for ten days, vomiting for several days, lately fecal in character. Abdomen distended and tender throughout. Operation, February 14, 1905. Intestinal resection and circular enterorrhaphy. Gangrene of small portion of ileum, from constriction by adhesions. Recovered and discharged March 21, 1905.

16. *Acute Intestinal Obstruction.* G., aged forty years, female. Abdominal pains and constipation for a week; no movement nor flatus for three days, fecal vomiting for two days. Operation, December 26, 1905. Intestinal resection and circular enterorrhaphy. Lower ileum tightly adherent to right Fallopian tube; absolute obstruction and gangrene. Bowel above resection emptied of two quarts of fecal matter. Right salpingo-oöphorectomy. Glass tube to pelvis. Died December 27, 1905.

17. *Acute Intestinal Obstruction.* P., aged thirty-five years, male. An operation for appendiceal abscess done September 23, 1905. Did well for one week; then symptoms of acute intestinal obstruction arose. Operation (Dr. G. G. Ross), September 30, 1905. Eight inches of lower ileum resected for destruction by inflammatory thickening and adhesions. End-to-end anastomosis. Died, October 10, 1905.

18. *Acute Intestinal Obstruction.* P., aged twenty-nine years, male. Operated on for appendicitis with diffuse peritonitis, November 11, 1905. Glass tube drainage. Did well for three weeks; then developed abdominal distention, pain, vomiting; no flatus passed. Re-operated December 2, 1905. Obstruction of

ileum from adhesions two feet above ileocecal valve. All adhesions released, contents massaged into contracted gut; abdomen flushed with saline solution. Glass tube to pelvis. Recovered and discharged December 23, 1905.

19. *Acute Intestinal Obstruction.* R. B., aged six years, female. In September, 1905, brought to Hospital in third attack of appendicitis, third day of attack. Gangrenous appendix removed, serous fluid in pelvis, glass tube drain. Fecal fistula on fourth day, closed spontaneously on sixth day. Discharged October 7, 1905. On October 16, re-admitted with history of sudden abdominal pain, vomiting, no flatus. Operation, twelve hours after onset of attack, October 16, 1905. Obstructing bands around ileocecal region removed. Recovered and discharged November 12, 1905.

20. *Acute Intestinal Obstruction.* R. C., aged eleven years, female. On December 12, 1905, patient was admitted on third day of attack of appendicitis. Perforated and gangrenous appendix immediately removed, large pelvic abscess drained by glass tube and gauze strips. Fecal fistula formed December 14. On December 26, developed acute intestinal obstruction. Immediate operation by Dr. H. C. Deaver, showed band of obstructing ileum, which was bluish black. Band cut, normal color returned to gut. Fecal fistula closed by sutures. Recovered and discharged February 3, 1906.

21. *Acute Intestinal Obstruction.* E. F., aged twelve years, male. For three months general abdominal pain, most marked on right. Very tender over appendix. Operation, January 28, 1906, moderately swollen appendix removed from behind cecum. Up in wheel-chair February 8, 1906. Developed sharp pain in left groin, pallor, weak pulse, cold extremities. Next day pain worse, became very severe; vomited. No tenderness, no distention; flatus only by rectal tube. Next day better, no pain all day, but became tympanitic toward afternoon. General condition good, but vomited three times in evening, last vomitus being coffee-ground in character. Operation, February 10, 1906, ether. Incision five inches long. Two feet above ileocæcal valve an area of ileum six or eight inches in length presented longitudinal patches resembling typhoid ulcers. Mesenteric glands enlarged. Entire large gut and some of small gut paretic and distended.

First two feet of jejunum collapsed. Here was a discolored area, with a "kink" in the bowel. When this was relieved normal color returned to the gut. By means of rectal tube and manipulation from within, bowel was emptied of nearly two pints of fluid, some of it being oil from previous enema. Recovery was uneventful, and patient was discharged March 1, 1906.

22. *Acute Intestinal Obstruction.* A. C., aged ten years, female. Admitted February 16, 1906, on twelfth day of attack of appendicitis. Large abscess opened, appendix not searched for, and adhesions not disturbed. Glass tube and gauze drain. After being out of bed some days developed acute intestinal obstruction on March 21. Immediately operated by Dr. H. C. Deaver. Mass of adhesions in the pelvis, viscera being incorporated in one mass. All adhesions separated; appendix removed from pelvis. Glass tube drain. Recovered and discharged April 22, 1906.

23. *Acute Intestinal Obstruction.* D. K., aged thirteen years, male. Operation for suppurative appendicitis three years ago. Acute intestinal obstruction developed two days ago. Patient in state of profound collapse, no pulse at wrist, respiration rapid and shallow. Cold sweat on face and extremities; fingers blue, cold and shrivelled. Abdomen enormously distended, coils of intestine being easily outlined. Immediate operation by Dr. H. C. Deaver, February 19, 1906. Local anæsthesia by cocaine. Gush of straw-colored fluid. Intestines red and injected, and enormously distended. One constricting band completely occluding lower ileum was divided. Bowel black and blue for five or six inches, but color gradually returned. Numerous other adhesions were not disturbed. A trocar was introduced into bowel and 100 c.c. of liquid fæces drawn off. Bowel then sutured to abdominal wall, puncture in gut enlarged; rubber tube introduced into bowel and sutured. Patient returned to bed. Within an hour pulse could be felt at wrist. Fecal fistula drained well. Twelve days later the patient was etherized, and about three inches of bowel forming the fecal fistulas were excised by Dr. H. C. Deaver, and an end-to-end anastomosis done with the Murphy button. All adhesions were separated and bleeding points ligated, glass tube drainage to pelvis. Uneventful recovery ensued, and the patient was discharged April 13, 1906.

24. *Acute Intestinal Obstruction.* A. J., aged twelve years, male. Admitted to Hospital on eighth day of attack of appendicitis. Immediate operation by Dr. H. C. Deaver, large abscess evacuated, and gangrenous appendix removed. Recovered. After being home three weeks developed sudden intense abdominal pain, intermittent in character. Readmitted four hours after the occurrence of the pain. Immediate operation by Dr. H. C. Deaver, March 15, 1906. Numerous adhesions found, involving small and large intestine. All separated. No evidence of acute peritonitis. Recovered and discharged April 12, 1906.

25. *Acute Intestinal Obstruction.* W., aged thirty-eight years, female. Three years ago was operated on by a gynecologist, who removed one ovary and suspended the uterus. Patient suffered a nervous breakdown two years subsequently, and was confined to bed about a month. Four days before admission to the German Hospital, she contracted a cold in the head, two days later was attacked by a sharp pain below umbilicus. Bowels constipated. Vomiting. Moderate general distention, slight general tenderness, most marked below umbilicus in iliac regions. Operation May 21, 1906, showed small bowel adherent to right ovary and to floor of pelvis. Adhesions released, obstruction relieved; recovered, and doing well.

26. *Acute Intestinal Obstruction.* G., aged twelve years, male. Pelvic abscess opened, and gangrenous perforated appendix removed on fifth day of attack by Dr. H. C. Deaver. Did well for two weeks. Suddenly attacked by severe abdominal pain and vomiting. Wound reopened, May, 1906, by Dr. H. C. Deaver, revealing a mass of adhesions, mostly in pelvis. About three feet of ileum was involved in this mass. All adhesions separated. Patient is doing well.

27. *Dynamic Intestinal Obstruction.* B., aged sixty-nine years, male. Four days before admission was attacked by sharp abdominal pain, with vomiting. Pain and vomiting persisted. Seen by Dr. J. C. Wilson, who diagnosed intestinal obstruction, and advised immediate operation. No bowel movement nor flatus. Abdominal examination shows large complete inguinal hernia on right side, and small incomplete inguinal hernia on left, both being easily reducible. Abdomen generally distended and

tympanitic, especially in lower segment. Tender throughout. Operation, May 6, 1906, showed upper portion of ileum collapsed, no kink, and no adhesions; slight manipulation of the bowel restored its normal calibre. Patient had a large loose bowel movement following the operation. Uneventful recovery. Discharged May 17, 1906.

28. *Enterovaginal Fistula.* L., aged forty-four years, female. Panhysterectomy for carcinoma done May 6, 1905; on May 18, enterovaginal fistula developed. On June 10, 1905, abdomen was opened again, fistula found in small bowel, six feet from ileocæcal valve, adherent to vagina. Sutured. After operation had vesicovaginal fistula for a few days, but this closed spontaneously. Recovered and discharged June 29, 1905.

29. *Fecal Fistula.* G., aged twenty-one years, female. Fistula in sigmoid, following some pelvic operation. On January 28, 1905, fistulous tract was excised, and opening in sigmoid closed with sutures. Rubber tube and gauze drainage. Recovered and discharged February 13, 1905.

30. *Fecal Fistula.* K., aged thirty-two years, male. Operated on elsewhere for appendicitis, and discharged from hospital with sinus in right iliac fossa. About eighteen months ago a fecal fistula developed. Four weeks ago an ischiorectal abscess evacuated. Operation, December 1, 1904. Fistulous tract found to communicate with cæcum, opening in bowel being about the diameter of a lead pencil. Defect in cæcum closed with two rows of sutures. The ileocæcal valve was encroached upon, so an ileocolostomy was done with silk. Gauze packing to check oozing from bed of adhesions. On January 17, 1905, the ischiorectal space was reopened and a rubber tube inserted to facilitate drainage. The opening in the cæcum not having healed was again sutured, and an omental graft was stitched over it. Gauze and rubber tube drains. On February 1, the fecal fistula was still discharging, and there appeared to be three holes in cecum. On February 6, a left-sided ischiorectal abscess developed; this was incised, and the abdomen was opened to attempt a more radical cure of the fecal fistula. The site of former anastomosis was located; the leum on the proximal side was clamped, divided, and the proximal end closed. The distal ileum, with the cæcum and a portion of

the ascending colon, were then resected, and a lateral anastomosis done between the ileum and the transverse colon, where both portions of gut appeared to be healthy. Two weeks later, February 14, 1905, there was discovered a discharge of feces in the wound. This continued, when patient was discharged March 3, 1905. He died not long afterward.

31. *Fecal Fistula.* S., aged thirty-four years, female. Operated on elsewhere in August, 1904, for right inguinal strangulated hernia. Resection of gangrenous bowel was done, and operation hurriedly finished on account of low condition of patient. Operation May 11, 1905. Resection of involved intestine, with end-to-end anastomosis. Gauze drain. Recovered and discharged May 5, 1905.

32. *Fecal Fistula.* L., aged twenty-two years, male. Operated on in another city February 2, 1905, for appendiceal abscess. Nine days later was again operated on for intestinal obstruction; on this occasion the abdomen was drained with glass tube to the pelvis. Four days after this second operation a fecal fistula developed, and has persisted since. Operation, November 11, 1905. Fistulous opening in cæcum closed by sutures. Appendix removed. Gauze and rubber tube drains. Recovered and discharged, November 25, 1905.

33. *Fecal Fistula.* H., aged thirty-seven years, male. Operated for strangulated inguinal hernia twelve years ago. Ten years ago operated for intestinal obstruction due to bands, resection of bowel being done, and end-to-end anastomosis, using the Abbey rubber ring. Only one segment of the ring was passed. Six months later fecal fistula formed in scar. Operation, February 14, 1906. Several large openings found in ileum, necessitating resection, which included site of anastomosis of ten years ago. In all, twelve inches of gut removed. End-to-end anastomosis with suture. Recovered and discharged, March 20, 1906.

34. *Fecal Fistula.* K., aged thirty-three years, female. Puerperal abscess six years ago, which was allowed to open spontaneously in left iliac region. Sinus persisted, and feces have discharged for two weeks. Operation, January 4, 1906. Opening found in sigmoid; sutured. Recovered and discharged, February 23, 1906.

35. *Fecal Fistula.* W., aged twenty-four years, male. Operation for appendicitis four years ago. Hernia occurred in the scar,

for which radical cure was done, but not in the German Hospital; this was followed by a fecal fistula. Operation for the cure of the fistula, January 6, 1906. Opening in cæcum sutured, and reinforced with flap of parietal peritoneum. Drain through right flank, allowing complete closure of anterior belly wall. Recovered and discharged February 13, 1906.

36. *Intussusception.* M., aged twenty-three years, male. Ate indigestible food two days before admission; soon seized with acute abdominal pain; was given violent purges without producing a bowel movement. Has been vomiting for thirty-six hours. Operation by Dr. G. G. Ross, August 3, 1905. Ileum invaginated into colon through ileocæcal valve. Irreducible. Ileocolostomy with Murphy button. Saline solution left in abdomen. Glass tube to pelvis. Died August 8, 1905.

37. *Intussusception during Typhoid Fever.* S., aged nineteen years, female. During height of attack developed symptoms of intestinal obstruction. Passes mucus from rectum. Operation, March 19, 1906. Laparotomy, ileocolic intussusception found, easily reduced by manipulation. Abdomen closed. Uneventful recovery.

38. *Chronic Volvulus of Ileum.* E. B., aged forty-six years, female. Six years ago was operated on for appendicitis, and soon after an incisional hernia which developed was repaired. For two years past has had severe pain around umbilicus. Has had attacks of pain with vomiting, sometimes fecal in character; after acute attacks subside, has nausea for several days, and passes blood in stool for two or three days. Has had about twenty-four such attacks in all, only four with fecal vomiting. A mass can be felt in the right iliac fossa. Operation, March 5, 1906. No adhesions between bowels, but lower ileum is constricted and its walls are friable and diseased, tearing loose from mesentery during examination. Ileum above the obstruction anastomosed to the transverse colon. Recovered and discharged April 23, 1906.

39. *Typhoid Perforation with Appendicitis.* N., aged forty-three years, male. During the height of fever developed symptoms of peritoneal inflammation. Operation, May 30, 1905. Appendix deeply congested and removed. Seropus in pelvis. Low-grade peritonitis, with recent adhesions among coils of lower ileum. Several ulcers in ileum, with fibrin on surface. Perforation found in base of one ulcer, fecal matter exuding. Sutured. No irrigation.

Glass tube to pelvis. Widal reaction negative. Recovered, and discharged June 12, 1905.

40. *Ulcerative Colitis.* C., aged thirty-six years, male. Blood and pus in stools with occasional vomiting for nearly three years. Operation, April 29, 1905. Lumen of transverse colon found entirely occluded by firm masses of feces; sigmoid flexure and descending colon contained large masses of scybalous feces. Cecum incised, fecal contents found. Wall of colon much thickened. Opening in cecum sutured. Ileosigmoidostomy done. Patient died May 3, four days later. At autopsy, ascending and transverse colon seat of extensive ulceration, mucosa motheaten and fenestrated; entire lumen occluded by inspissated feces; site of anastomosis gangrenous, sutures had sloughed.

SUMMARY OF OPERATIONS ON FORTY PATIENTS.

N. B. Several patients had more than one operation.

Operation.	*Total.*	*R.*	*D.*	*Mortality. per cent.*
Colostomy	2	1	1	50.0
Enterolysis for obstruction by adhesions, etc.	8	8	0	00.0
Enterorrhaphy for fecal fistula	7	7	0	00.0
Enterorrhaphy for typhoid perforation	1	1	0	00 0
Enterotomy for obstruction	1	1	0	00.0
Ileocolostomy	6	5	1	16.6
Ileosigmoidostomy	6	3	3	50.0
Intussusception reduced	1	1	0	00.0
Laparotomy for dynamic intestinal obstruction	1	1	0	00.0
Laparotomy to release kink causing obstruction	1	1	0	00.0
Resection of small intestine with end-to-end anastomosis	5	3	2	40.0
Resection of cæcum, including portions of ileum and ascending colon	3	2	1	33-3
Resection of hepatic flexure of colon including portion of ascending and transverse colon, with end-to-end anastomosis of colon in one case, and a lateral anastomosis of ileum to transverse colon in the other	2	2	0	00.0
Resection of sigmoid flexure and ileosigmoidostomy	1	1	0	00.0
Sigmoidoproctostomy	1	0	1	100.0
Total	46	37	9	19-3

THE RADICAL CURE OF FEMORAL HERNIA, WITH A REPORT OF ONE HUNDRED AND SEVENTEEN OPERATIONS.

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Between the years 1891 and 1906, I performed 117 operations for femoral hernia in 104 patients. In 32 of these operations the patients were children between the ages of two and fourteen years; 9 were males and 18 females. In 3 operations the patients were under five years of age; in 17 operations the patients were from five to ten years; in 14 operations the patients were from ten to fourteen years.

Eighty-three operations were done upon adults, or patients between fourteen and seventy years of age. Of these patients 12 were males and 65 females.

It will be seen that in children the relative frequency of femoral hernia in males to females is 1 to 2; while in adults it is about 1 to 6. The relative frequency of femoral hernia to inguinal hernia, as given by Macready (*Statistics of the London Truss Association*) is 1 to 12. At the Hospital for Ruptured and Crippled, in 57,380 cases of inguinal and femoral hernia it is 1 to 17.

The 15,028 cases of inguinal and femoral hernia operated upon for radical cure, at various clinics and by various surgeons, collected by Pott (*Deutsche Zeitschr. f. Chir.*, 1903) show 933 operations for femoral and 14,095 operations for inguinal hernia, or a proportion of 1 femoral to 15 inguinal.

My own operative statistics for the radical cure of hernia shows almost exactly the same percentage, namely, 117 femorals in a total of 1678 cases, or 1 operation for femoral to 14 for inguinal hernia.

Previous statistics have almost uniformly given a slightly higher

mortality in operations for femoral than for inguinal hernia, and also a smaller percentage of permanent cures. Unfortunately, there have been very few reports of any large series of operations for femoral hernia, and still fewer reports of cases traced to *final* results.

The careful analysis of Pott (*loc. cit.*) of 933 cases of femoral hernia operated on prior to 1903 shows that the results of operations for radical cure in femoral hernia have been distinctly inferior to those in inguinal; the percentage of permanent cures in inguinal being 82 per cent., and in femoral being 70.5 per cent. He further shows that the results were much better when the femoral canal was closed than when the sac was simply excised and the wound closed without suture of the canal; the results being 63.3 per cent. of cures without suture and 76 per cent. with suture.

A very large number of methods have been proposed and many of these are still in vogue; however, more by reason of the fact that they were devised by some distinguished surgeon than by the fact that practical experience has demonstrated their value.

The hope of supplying some of the data necessary for determining the relative merits of different operations for femoral hernia, is the excuse for the present paper.

The earlier operations consisted in simple excision of the sac without any attempt to close the canal. In such operations there was usually a recurrence within a year, in 30 to 40 per cent. of the cases. In 1890 Dr. Wm. T. Bull (*Med. Rec.*, vol. lvii) reported thirteen cases of femoral hernia operated upon by this method, eight of which were traced beyond a year, with three relapses. In 1889 and 1890 Cushing and Marcy published a form of purse-string suture of the femoral ring and called it a "quilted" suture.

In later methods of operation, in addition to ligating the sac, an attempt was made to close the femoral canal. These methods may be divided into two main groups, *i. e.:*

1. Those in which an effort was made to close the canal by means of suture applied in a great variety of ways: (*a*) suture of external ring; (*b*) suture of internal ring.

2. Those in which it was attempted to close the canal by means of muscle osteoplastic or heteroplastic flaps.

The suture method may also be divided into two groups: (*a*) of external ring; (*b*) of internal ring. Some of the methods of suturing the canal are exceedingly complicated, *e. g.*, the Lotheisen and Gordon operations, 1898–1900, and more recently those devised by Roux and Nicoll. The reasons advanced by the authors in favor of adopting these more difficult and complicated procedures for the cure of femoral hernia are all based on the supposition that femoral hernia is not readily curable by simpler methods. With this opinion I strongly desire to take issue.

The first paper of note going far to prove that almost perfect results can be obtained with simpler methods (suture of external ring) was that of Bassini (*Arch. f. klin. Chir.*, 1894, vol. xlvii), who, in describing his own method for the radical cure of femoral hernia, reported 54 cases operated upon by the same, of which 41 had been traced from one to nine years without a single relapse.

The technique of Bassini's operation was exceedingly simple and easy of performance, consisting in high ligation of the sac and uniting of the roof of the canal with the pectineal fascia and muscle by means of seven interrupted sutures.

A recent paper by De Garmo (*Annals of Surgery*, 1905), reporting 110 operations for femoral hernia by a method similar to Bassini's, with but one relapse, furnishes additional proof of the strongest kind of the value of the simpler methods.

In my own case, two methods only have been employed:

1. *Bassini's method*, which was used in sixteen cases, with one relapse, the only variation being the substitution of kangaroo tendon for silk used by Bassini. The case in which a relapse occurred was the only one in which there was suppuration, and to this fact the relapse may be attributed. The relapse consisted, however, only in a slight bulging of the canal, which disappeared after the use of a truss for a short time, and the patient is well nine years afterward. It can, therefore, hardly be classed as a true recurrence.

2. *The purse-string suture method*, which has been employed in 101 cases. It is somewhat similar to an operation devised by Cushing, of Boston, in 1888, but differs from it somewhat in technique. The operation may be briefly described as follows:

An oblique incision is made one-quarter to one-half inch below Poupart's ligament and parallel with it, almost identical with the incision made for inguinal hernia, only slightly lower and a little shorter. The sac with the mass of extraperitoneal fat that almost always surrounds it is then freed well up into the femoral opening. The masses of fat are carefully removed, the sac itself, by gentle traction, is brought down well beyond its neck to a point where it widens into the general peritoneal cavity. It is always opened before ligature, to make sure that it is empty; if omentum is present, this is tied off and removed. The ligature having been placed well beyond the neck by transfixion, it is carefully tied and the sac removed. When the stump of the sac has been pushed through the opening into the abdominal cavity, there is no longer any funicular process present in the femoral region. With a curved Hagedorn needle,[1] threaded with kangaroo tendon of medium size, the suture is placed as follows: The needle is first passed through the inner portion of Poupart's ligament or the roof of the canal, then downward, taking firm hold of the pectineal fascia and muscle, then outward through the fascia lata overlying the femoral vein, and finally upward, emerging through the roof of the canal about one-fourth of an inch distant from the point of entrance. On tying this suture, the floor of the canal is brought into apposition with the roof, and the femoral opening is completely obliterated. The skin and superficial fascia are closed by means of an interrupted catgut suture and a sterile dressing is applied, without drainage. The first change of dressing is made at the end of one week. The patient is kept in bed for two weeks and allowed to go home at the end of two and one-half weeks. A

[1] In my earlier cases I used a special needle, somewhat resembling an aneurysm needle, for the introduction of the purse-string suture, but soon gave it up for the Hagedorn needle, which, with a little care, may be used with perfect safety and much greater facility. I use no needle-holder.

firm spica bandage is worn one week after leaving the hospital, at the end of which time no further support is needed.

The purse-string suture thus applied accomplishes exactly the same thing as Bassini's operation for femoral hernia, and it has the advantage that it is much more easily and quickly performed.

In the 101 cases operated upon by this method, most of which have been very carefully traced, there has not been a single relapse.

The final results of the present series of cases, as far as traced, are as follows: 5 well from ten to twelve years; 17 from five to ten years; 35 from two to five years; 12 from one to two years; or 69 cases sound from one to twelve years, and 57 well over two years.

As regards the ages of the cases operated upon my statistics show the following:

Under 5 years	3
" 5 to 10 years	15
" 10 to 20 "	19
" 20 to 30 "	32
" 30 to 40 "	29
" 40 to 50 "	11
" 50 to 60 "	5
" 70 "	1

These cases have in no way been selected and the method has been employed in the largest herniæ with equally good results. There have been no complications, with the exception of a slight phlebitis in one case, which soon disappeared.

Mortality. In the non-strangulated cases there has been no mortality, and only one case of suppuration. In the strangulated cases, four in number, there was one death, in a woman fifty-five years of age, in whom strangulation had existed for three days and the patient was in a desperate condition, necessitating resection of a large portion of the intestine. In another case of strangulation, a man seventy years of age, operation was performed in a tenement house in a small town. The patient apparently made a good recovery, but died two to three weeks later of some unknown cause. The physician in charge did not believe that death was in

any way connected with the operation, although I do not think it fair to exclude the operation as a possible cause.

In the most recent edition of v. Bergmann's *Surgery* it is stated that "simply closing the external femoral ring would accomplish little more than closing the external inguinal ring. Modern methods attempt to close the entire canal, including the internal ring."

Bacon, of New Haven, attempts to apply the same line of reasoning to the femoral as to the inguinal canal. He argues that the lesson taught by Bassini in inguinal hernia, that the proper place to start the obliteration of the canal is the internal ring, should apply with the same force to the femoral canal. He states that "the plans for the closure of the femoral canal have, until most recently, been subject to the same insidious defect which invalidated, more or less completely, the older of the so-called modern operations for hernia of the inguinal form, in that however firmly the crural end of the femoral canal has been closed, its abdominal end has not been satisfactorily obliterated, and thus the opportunity has remained for a knuckle of gut or a bit of omentum to insinuate itself along the track of the old hernia, and so, in a certain proportion of cases, provoke its recurrence."

The earlier purse-string methods for closing the femoral canal, first brought out by Cushing and Marcy, 1888–1889, while admitting that they are a distinct advance over the previous operations of plugging or invaginating tissues into the femoral opening, Bacon considers inferior to the method of Bassini. However, in the latter, he says there are two weak points: (1.) That the abdominal orifice of the femoral canal is not closed. (2.) That "the breach in the belly wall is attacked at the wrong end of the femoral canal; furthermore, that the crural arch itself is closed at a mechanical disadvantage."

Kammerer in a more recent article on "Femoral Hernia" (*Annals of Surg.*, 1904, vol. xxxix) gives expression to a similar criticism, and states that Bassini's method practically only closes the external femoral ring. He further adds, "The same, I think, can be said of the various forms of the purse-string suture, which, if anything, only creates greater tension." Kammerer believes that the

method of Fabricius, in which an attempt is made to obliterate the opening at the internal ring by dividing the superior cornu and some of the fibres of Poupart's ligament sufficiently to relieve all tension and permit the parts to be sutured to Cooper's ligament, is a distinct improvement over Bassini's operation or the purse-string suture, and the Lotheisen and Gordon method he regards as still better.

The point I would make in discussing these various criticisms of the Bassini and purse-string methods, is that the value of an operation in surgery cannot be settled thus easily, and least of all can it be estimated according to the degree to which it fulfils certain theoretical, geometrical, or mechanical conditions. There are a great many other factors that enter into the question. Let us take, for example, the McBurney operation for inguinal hernia. Theoretically, it seemed an ideal operation. Yet experience proved it to be of little value, because it failed to take into consideration the fact that scar tissue subjected to pressure or tension has the power of stretching or yielding indefinitely. Many of the more complicated methods of femoral hernia, while they may be theoretically and mechanically correct in principle, depend for their success upon some seemingly minor factor which is given little consideration, yet which may completely annul their supposed superiority. This is well illustrated by those methods in which the canal is perfectly closed and obliterated by means of metal nails or silver wire sutures; yet, the very presence of these foreign bodies often bring about secondary sinuses with suppuration, which, in turn, may be the chief cause in producing a relapse.

As to the Gordon method, so strongly advocated by Bacon and Kammerer, as well as the other methods of closing the femoral ring from the inner side, necessitating opening the inguinal canal, the possibility of an inguinal hernia resulting from an attempt to cure the femoral, should not be lost sight of. Not a single surgeon has reported more than an insignificant number of cases operated upon by any of these methods, and in none of the reports were the cases traced any length of time.

While we may be willing to grant the truth of the statement of

Bacon that "it is far better to follow a mechanically correct paradigm than to practice an operation whose mechanical deficiencies must be supplemented by peculiar skill or extraordinary experience on the part of the operator," yet it must be conceded that if the success of the simpler operation of Bassini and the purse-string methods depended upon peculiar skill or extraordinary experience on the part of the operators, how much greater skill and experience would be required to successfully perform an operation like the Gordon method, for the understanding of which Bacon himself has thought it necessary to devote seven pages of description?

The value of an operation for femoral hernia, as the value of all operations in surgery, should, I believe, be estimated not by trying to ascertain how nearly it fulfils certain theoretical considerations, however important they may appear to the individual surgeon, but by finding out to what extent they meet two very practical tests:

1. Simplicity, including safety.
2. Efficiency, that is, permanence of cure.

Of two methods of operation giving equally good results, that method which is the simpler, and more easily performed, should have the preference.

The purse-string method that I have described I have used in 101 instances without a single relapse. These operations, extending over a period of fourteen years, and including all varieties of femoral hernia, without distinction as to size of the hernia or age of the patient, would seem to show that the method had satisfactorily stood the practical tests that I have laid down. Moreover, it is the simplest in technique and most easily learned of all the various methods with which I am familiar.

In discussing my earlier results, Kammerer, *loc. cit.*, states that he does not believe sufficient time had elapsed to warrant definite conclusions as to my ultimate results, and quotes the statistics of Heidenthaler to show that femoral hernia in which the external femoral opening has been sutured recur very late, on an average after two years.

Heidenthaler's article was published in 1890, and Kammerer himself states that Bassini's article, published in 1894, represents the first systematic attempt to close the femoral canal in addition to ligating the sac. It is true that there were a few earlier cases reported by Marcy, Bull, and Cushing in 1889 and 1890, but these cases were manifestly too few and widely scattered, as well as imperfectly traced, to enable Heidenthaler as early as 1890 to draw any conclusions as to the interval of time between operation and relapse in cases operated upon with closure of the external ring.

At the Hospital for Ruptured and Crippled we have kept very careful records of all cases of relapsed hernia operated upon by various methods and in various clinics during the past sixteen years. An analysis of these cases, already published in previous papers, shows that in 504 relapsed cases, including all varieties of hernia, the relapse occurred during the first six months after operation in 83 per cent. and during the first year in 90 per cent. of the cases.

This experience is confirmed by the findings of Pott, who in a series of 145 collected cases found that recurrence took place within the first six months in 71.66 per cent., and during the first year in 91 per cent.

In these statistics no attempt was made to separate the femoral from the inguinal relapses, but in view of the point raised by Dr. Kammerer, I have recently made a study of the entire list of femoral cases, with the following result:

Within the past sixteen years, 28 cases of relapse following operation for femoral hernia have been observed at the Hospital for Ruptured and Crippled. Of this number the time of relapse is not definitely stated in three; in eleven, relapse took place within the first six months after operation; in six, between six months and a year; or seventeen relapsed within the first year, being equal to 68 per cent. Five cases (20 per cent.) relapsed after one year, and only three (or 12 per cent.) later than two years after operation.

The method of operation in these cases was not in all instances

definitely stated, but in the majority some attempt was made to close the external ring. These results fail to confirm the opinion expressed by Heidenthaler, that most of the relapses of femoral hernia occur after two years, but show that—the same as in inguinal hernia—the great majority of relapses are observed within the first year after operation, and only 12 per cent. after two years.

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A NEW METHOD OF UTILIZATION OF THE SAC IN THE RADICAL CURE OF HERNIA.

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Modern methods of radical treatment of inguinal and femora; herniæ, as at present apprehended, consist essentially in carrying out two principles: 1. The isolation and disposition of the sacl 2. The closure of the inguinal canal; or, in the case of femoral hernia, obliteration of the femoral canal. So many methods have been suggested for these various purposes that I almost hesitate to introduce another. And yet during the past years I have put in practice a method which is, in theory, simplicity itself, and which, it seems to me, has points of advantage justifying its presentation to you. So far as I have learned, it has not been carried out in this way by others before me, and I may, therefore, I think, claim it as an original procedure.

The method consists simply in utilizing what is usually entirely dissected away, namely, the sac, and in making of it the suture material with which the canal itself is closed.

Briefly, the procedure is as follows, especially with inguinal hernia: to isolate the sac, then to empty it and to clean it of all superficial fat. It is thus separated from the cord and made to appear as a distinct, separate structure up to the level of the internal ring. My usual procedure for many years has been to penetrate the abdominal aponeurosis at a point opposite the internal ring, with forceps with alligator jaw, made for the purpose, although these are not at all essential. The forceps introduced through this opening are made to appear lower in the inguinal canal and here to seize the end of the sac, and, in the act of with-

drawal pull it after them, and thus bring it out at the punctured point. Here I used to twist the sac, ligate the neck, and tack it in place with one or two chromicized sutures. I have now modified the procedure in such a way that instead of cutting off the

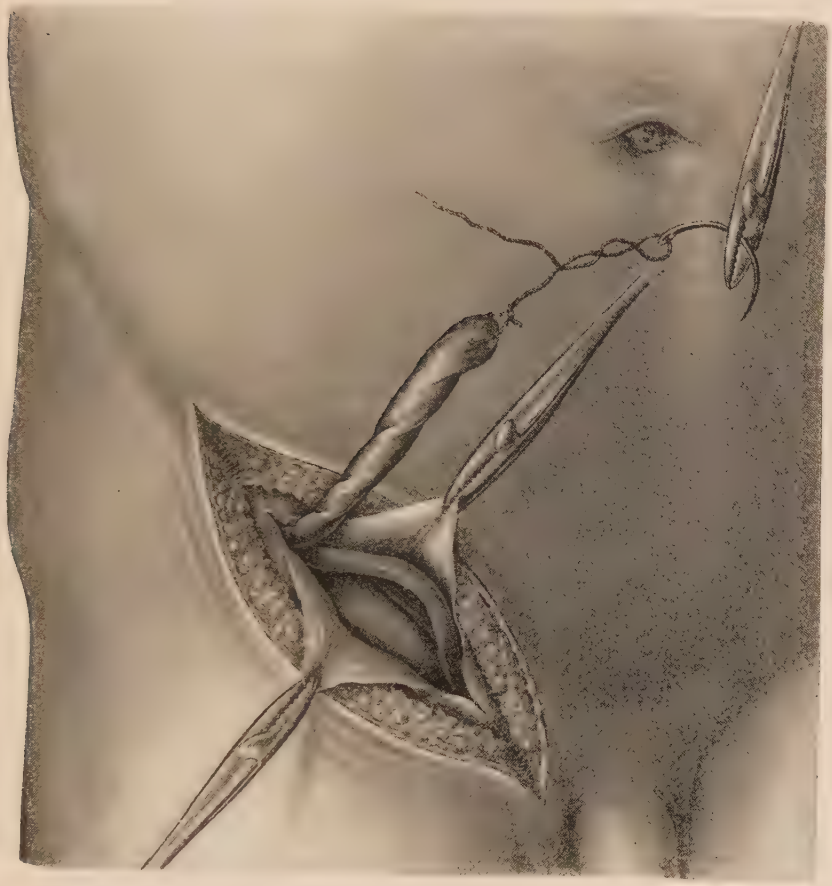

FIG. 1.—The method of isolating the sac and one way of securing its end, in order to lace up the ring with it.

sac outside the point where it is fastened, I utilize it as a band of suture material, with which a coarse but strong suture is made, binding together the lateral margins of the inguinal canal.

Of course, much will depend upon the thickness and length of

the sac. Old and large sacs will be far too cumbersome for this purpose, and short sacs will be too short to serve as sutures when twisted into a cord. These difficulties are easily overcome by either reducing the sac, cutting out a strip which can be used for the

FIG. 2.—One method of using a small sac after isolation in making a single-braided suture of the margins of the ring.

purpose in one case, or in the other, lengthening it by a division, such as is illustrated in the accompanying pictures, by which a sac two inches long can be so divided as to furnish a cord five or six inches in length.

Having prepared the sac, or so much of it as is needed for the purpose, it may be now used in two or three ways. One may thread it into the eye of a very large needle, such as is used for carrying the silk by which we manage a chain-saw, or one may

FIG. 3.—The method of using a shorter and thicker sac by partially dividing and elongating it and then using it as before.

use a Cleveland ligature-carrier, passing it through the tissues on either side as if it were an ordinary needle, then grasping the end of the sac and pulling it back through the openings thus made as the instrument is withdrawn. Sometimes I have passed into the

end of the sac a silk suture, threading it into the larger needle and making it serve as a means of traction, the procedure varying a little with the density and strength of the sac-wall. Again, in certain cases, that portion utilized may be divided into halves,

FIG. 4.—Another method of utilizing a redundant amount of sac tissue by splitting, making two tapes, and using these for a shoe-lace suture of the ring margins.

making, as it were, two tapes, which can be used for making a shoe-lace suture of the pillars of the ring by either of the expedients just mentioned. When the ends are drawn down at the

lower end of the ring, they may be tied and fastened with a suture.

The advantages of this method seem to me to be the following:

1. It affords almost as perfect and complete a method of closure of the inguinal canal as does any other.

2. It utilizes a portion of the sac which would otherwise be quite discarded, and substitutes fresh animal suture of the patient's own tissue for foreign animal material, while, at the same time, under ordinary circumstances, its sterility may be guaranteed.

3. While I have not had opportunity to demonstrate the fact, I think it fair to assume that such tissue so used does not disappear by absorption, as would tendon or other foreign material, but rather is organized and serves as an additional means of strength and security, forming, as it were, a series of bridges or transverse fastenings by which obliteration of the inguinal canal shall be more securely attained.

Of course, the method cannot be applied to all cases, and can never be expected always to displace other procedures, nor should one ever think of adopting it when he is not operating deliberately and in the absence of all infectious processes. The same principle, it seems to me, is applicable to many cases of femoral hernia, although here it would necessarily require some modifications.

I have not yet been able to resort to this procedure in a large number of cases, but in those in which I have so far used it, it has given very satisfactory results. Naturally, much time will be required for a final verdict. I would gladly induce my colleagues in the Association to make trial of it as they see fit.

A BRIEF HISTORY OF OUR KNOWLEDGE OF ASPIRATION IN EMPYEMA AND OTHER SURGICAL CONDITIONS.

By JOSEPH D. BRYANT, M.D.,
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Potain is to be regarded as the pioneer in this field, because he first applied the principle of siphonage to empyematous cavities. His siphon, the one comprising but a single tube, was first made known to the profession in 1869.[1] To this tube, introduced into a trocar opening, were attached two others, in T- or Y- shape. The upper was connected with a vessel, which was filled with fluid and held above the level of the bed, while the lower was connected with a vessel below the level of the bed. The inferior tube and vessel then acted as a siphon, and as the contents of the pleura were evacuated by siphonage, the medicated water in the upper vessel passed into the cavity, irrigating it and applying antiseptics. This primitive attempt at siphonage was intermittently used, and, as duly stated, combined with lavage. Numerous modifications of Potain's apparatus soon followed, and some of these may be mentioned later.

But, in the meantime, Playfair,[2] of England, had introduced in 1872 a method which he termed "subaqueous drainage." A tube of rubber armed with a glass index was introduced through a trocar opening, and allowed to rest in a graduated glass vessel containing water and placed under the bed. The tube was sealed to the chest-wall. This apparatus was so modified that patients could walk about, and was therefore "permanent siphonage." After some brilliant results it fell into disuse, because air *would* sometimes gain admission into the pleural cavity. Nevertheless, Playfair seems entitled to priority for the introduction of continuous

drainage. He doubtless anticipated Bulau by some years, and Cestan, in his work on empyema, calls siphonage the "Playfair-Bulau method."

Bulau's method of permanent siphonage is said to have been devised independently by its author in 1876, and was used by some of his colleagues soon afterward. It probably did not get into print until 1881.[3] It differs but little from that of Playfair. A drainage-tube was sealed into a trocar opening; a rubber tube was attached, communicating with a bottle filled with fluid. Originally used in bed, the apparatus was made portable. The method came into wide use in Germany. In this connection we may state that Bulau and his colleagues claimed that permanent siphonage is really, in part, an aspiration procedure, in that the act of siphonage lowers intrapleural pressure and tends to cause a partial vacuum. There is, therefore, perhaps, no radical difference between aspiration siphonage and direct aspiration.

It is probable that Tachard, a Frenchman, anticipated Bulau in the use of permanent siphonage, as he claims to have used it in 1874, while ignorant of Playfair's work. In any case, his apparatus was used only after pleurotomy, and his own countryman, Cestan, does not appear to concede him any claim to priority in the use of aspiration drainage as a sole method of cure. In the same class with Tachard is Revilliod,[4] the eminent Swiss surgeon, who reported the use of permanent siphonage in 1880. He seems to have been unaware at the time of the labors of Playfair and Bulau; like Tachard, he regarded permanent siphonage as largely an incident in the after-treatment of pleurotomized cases, while awarding to it a much greater share of credit than did Tachard.

Denncé,[5] of Bordeaux, seems to have made an attempt to render Potain's method of intermittent siphonage a permanent procedure. His apparatus seems to have been practically that of Playfair, Bulau, and the others. We are ignorant as to how far he was aware of the work of his predecessors and contemporaries. But as Potain formally renounced the principle of siphonage in 1888 (in favor of pleurotomy), it is evident that the method of Denncé led to no practical results.

To sum up the state of affairs in the 80's of the past century,

Bulau's method was the one in common vogue. It was fairly well known in leading German clinics, and naturally underwent several modifications, which need not be detailed here.

In 1887, Subbotin,[6] a Russian surgeon, seemingly unaware of the work of his predecessors, proposed a method of aspiration drainage of all abscess cavities. The principle was that of siphonage, and was first demonstrated publicly on a case of empyema. The author seems to have had no idea that his apparatus could be used continuously, yet may deserve some credit for extending the principle of aspiration drainage beyond the mere empyema.

In 1889, Storch[7] reported what he considered to be an innovation in the application of the principle of permanent drainage. He applied the so-called Bunsen's aspirator, and describes his method as "bottle aspiration." A contemporary writer speaks of Storch's apparatus as a "modification of Bulau's." But Storch had used his principle as early as 1884, and regarded it as essentially different from Bulau's original effort. It is evident, however, that not a few authors of recent date have evolved the application of Bunsen's bottles from Bulau's original apparatus. The complicated use of three bottles is of course adapted only to bedfast cases. This leads us to remark that measures for permanent aspiration drainage must differ widely as to their applicability.

During the 90's of the past century the "method of Bulau"—as it had become commonly known—continued to gain adherents. The entire subject of siphonage had become concentrated under his name, and has, in part, up to the present day, gained ground in many quarters, naturally with many modifications and reservations.

The first great innovation in the shape of direct aspirations—as distinguished from the indirect or siphonage method—was introduced by Perthes[8] in 1898. This surgeon simply applied Bunsen's hydraulic pump—a laboratory instrument—for direct aspiration of pleural cavities. The drainage-tube is sealed into a thoracotomy incision, as usual; the discharge is collected and measured in a suitable vessel. A manometer is attached, so that when a certain degree of negative pressure is attained the suction is arrested. It was employed by its originator in cases where siphonage and

more radical procedures have failed. The results appeared to be favorable in the main, even as a last resort; but Perthes advocates his method before all for the radical cure of empyema.

According to Cestan,[9] Storch advised supplementing the ordinary siphonage principle with an atomizer bulb, by means of which the discharge of the fluid was hastened at intervals. The same authority states that Revilliod, through his pupil Archqwski, described a very similar apparatus. Both these authorities originally used the siphon principle alone.

Revilliod appears to have used a series of apparatus for each patient, which varied with the stage of the disease. Thus, at first, with patient in bed, a cumbrous siphon device was used; later, this was replaced by a small portable siphon apparatus; finally, when the discharge had become reduced to one or two ounces daily, the siphon was replaced by the aforesaid aspirating device, connecting with a rubber tube provided with an atomizer bulb.

During the present century the methods of Bulau and Perthes continued to claim recognition. In this country, not a few articles have appeared in which one or the other is advocated. Dr. W. Van Hook[10] has advocated Perthes' method. Dr. Usher,[11] of Wyoming, recommends the use of the air-pump, but does not mention the labors of his predecessors.

Burmeister,[12] a German surgeon in Chili, has recently recommended direct continuous aspiration drainage for cysts of the liver, pancreas, etc. He uses the so-called Finkenn suction-pump, both for aspiration and irrigation, with evident good results, and states that he has employed the method for years. He quotes only Potain.

At this time I respectfully beg leave to state that I am again calling attention to a plan of application of this form of treatment of empyemic cavities in the thorax, to which in the year 1900, in the Jacobi Festschrift, a somewhat brief allusion was made. At that time this case was correctly regarded to be the only one previously treated by the collapsed rubber bag as an agent of aspiration, at least so far as has yet been determined. It may not be amiss if again, at this time, the case be briefly narrated, with the idea of justifying the primary and other considerations

respecting the worth of a somewhat novel means of accomplishing a long-established purpose.

While the patient in question was riding rapidly down-town on a trolley-car his thorax was pierced at the right side by a thill or shaft of a vehicle going in the opposite direction, propelled by an unruly horse. One end of the shaft entered the pleural cavity at a point just below the right nipple and corresponding to the fourth rib, passed backward between the third and fifth ribs to

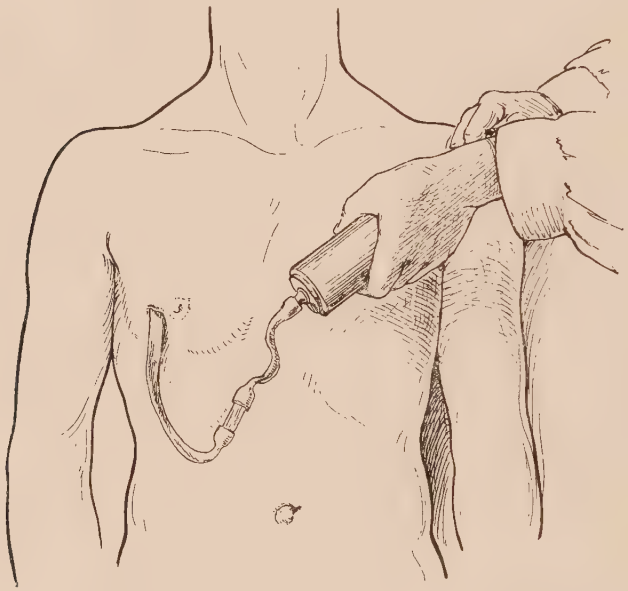

FIG. 1.—Using the syringe. Showing collapse of the tube from too rapid effort at withdrawal of the fluid.

about their posterior third, and escaped at the right side, lacerating extensively the pectoral muscles. The lateral part of the fourth rib was broken into two fragments, each about four inches in length, the anterior fragment remaining attached to the fifth rib only by means of distinct intercostal tissues. The posterior fragment was likewise attached, but only by means of shreddy tissues. The opening into the thorax was about eight inches in length, corresponding to the space between the third and fifth

ribs, which were not injured. The external soft parts contiguous to the wound were obviously much lacerated. The lung was not injured.

I will not enter into the detail of the treatment, since, as far as this case is concerned, in this connection, the real problem consisted in keeping the cavity drained and at the same time overcoming the deformity often attending recovery in cases of empyema from all causes.

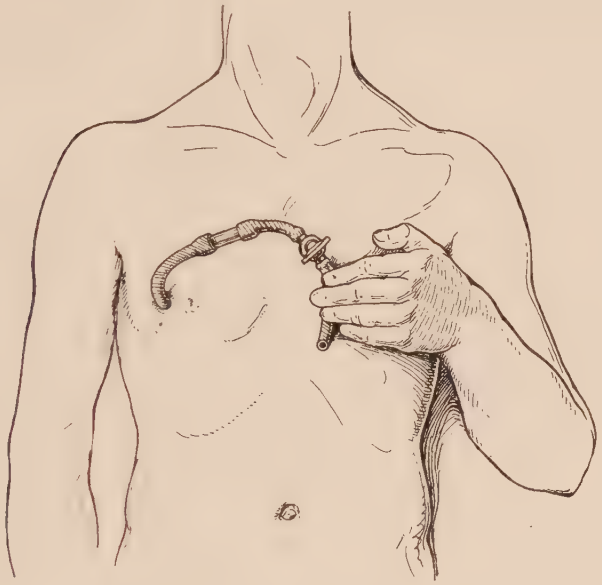

FIG. 2.—Syringe removed; thumbscrew turned, preventing the entrance of air; tube ready for application of rubber bag.

The idea that prompted the use of the rubber bag for the purpose of continuous suction was suggested to me by the interrupted employment of the syringe (Fig. 1) for the purpose of withdrawal of the fluid from the cavity. The collapse of the rubber tube during rapid withdrawal of the fluid by the syringe (Fig. 1) suggested a continuous slow exhaustion of both fluid and air from the cavity by means of the application to the tube of a collapsible rubber bag (Fig. 2). The introduction of the segment of glass into the rubber tube enables one to notice the passage of fluid along

the tube into the bag (Fig. 3), together with a thumbscrew to prevent the entrance of air during the emptying. Cleansing and adjustment of the bag were matters of easy conception and prompt adoption. The sealing of the tube to the chest and the application of the retaining dressing (Fig. 4) completes the outfit. A little later the attachment of a glass receptacle to collect the fluid in its passage toward the rubber bag was used by means of a T-shaped hard-rubber tube. This latter measure, however, was not deemed of sufficient practical importance to encourage a continued employment.

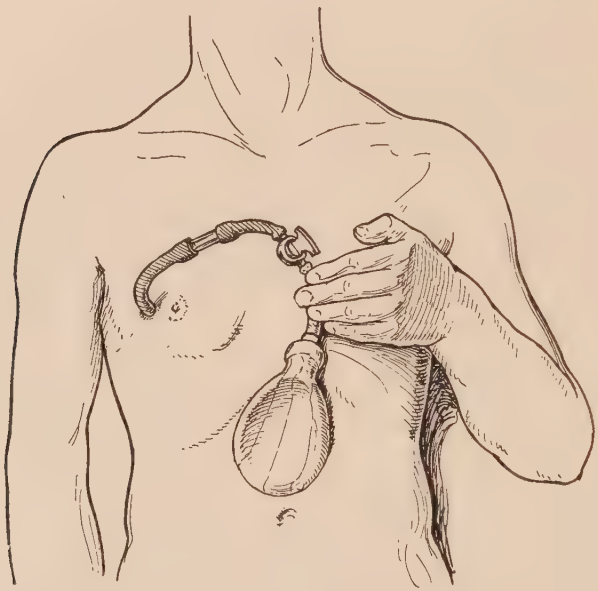

FIG. 3.—Collapsible rubber bag applied; thumbscrew turned and bag in action; glass segment shown.

The recovery of the patient already cited without special deformity or interference with respiratory function prompted the determination to apply again the apparatus with renewed opportunity. Soon after, a patient with extensive right-sided empyema, was referred to me for treatment by my colleague, Dr. Janeway. After excision of a small portion of rib at the usual site and the

evacuation of the empyemic products, the apparatus was applied. The history of this case strongly suggested the fact that the empyema was secondary to pulmonary abscess, dependent on tuberculous involvement. At first the apparatus removed the discharges from the empyemic cavity as soon as formed; later, however, the power of suction was frequently quickly lost, because of the entrance of air into the cavity, thereby promptly disposing of the vacuum. When the vacuum in the thorax was suitably maintained, the respiratory movements of the chest were syn-

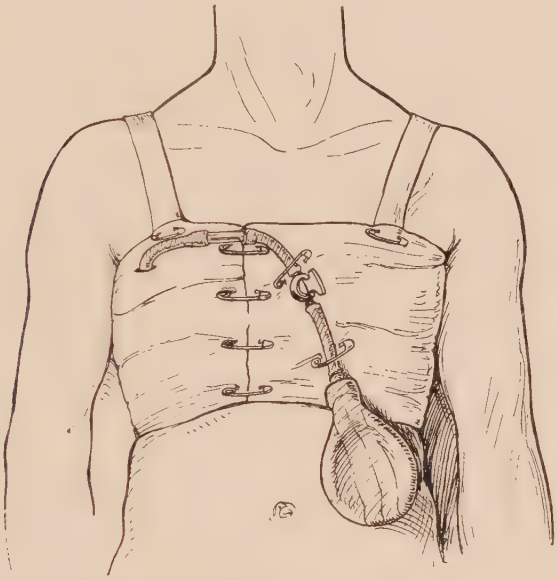

FIG. 4.—Dressing applied; apparatus fastened in place and bag in action.

chronously indicated by the changing dimensions of the rubber bag; respiratory inflation of the thorax was attended with a corresponding increased inflation of the bag. The uncertainty of maintaining the integrity of the vacuum in this case was, a little later, found to depend on the fluctuating control exercised by some presumptively cumulative or movable substance over the entrance of air through a pulmonary perforation of minute or changeable dimension. It is therefore noted at this time that any uncertainty regarding the presence of pulmonary perforation in a case of em-

pyema can be quite well settled by this measure—in any event after a little delay in unhealed perforations.

In another case, the sequel of pneumonia, forty-five ounces of pus were aspirated from the left pleural cavity. The apparatus was applied, but behaved badly, exercising suction in an interrupted manner at varying intervals. Cough occasionally attended its action, and also the introduction of fluid into the cavity for the purpose of estimating its dimensions. Finally, these manifestations suggested the thought that pulmonary perforation might be present, which fact was confirmed by the expectoration of methylene blue introduced into the empyemic cavity for the purpose. The physician in charge of this case candidly suggested that the perforation might have been caused at the outset by the aspiration-needle or the trocar, the introduction of the latter having been attended with transient though decided hemorrhage. This case, however, was healed entirely in eight weeks, although characterized by the abundant discharge of fœtid pus during much of the time.

The remainder of this brief paper will be restricted to: 1. The method of application. 2. The duration of treatment. 3. The practical utility of the plan.

Regarding the application of the apparatus. As can readily be surmised, it is not easy so to adjust it to the chest-wall as to maintain an active vacuum for a considerable length of time. The difference in the topography of the external surface of the chest, the movements incident to the respiratory act, and other disturbing influences, are often sufficient to shorten unduly the periods of practical activity of the apparatus, because of the entrance of air from without through the external opening. The use of adhesive plaster, of rubber tissue applied with chloroform at the borders, of wet absorbent cotton, and of tenacious compounds like oxide of zinc ointment, are in order, each one of which is serviceable in direct proportion to the care taken in the application. I desire at this time to admonish that especial care should be taken in the application, or contiguous substances may be forced through the opening by atmospheric pressure into the cavity, as once happened with absorbent cotton under my notice. The duration of treatment will depend substantially on the considera-

tions kindred to those of other parts of the body when suffering from similar afflictions. The nature of the infliction and of the complications, the care in the cleansing and drainage during the course of recovery, will exercise potent influence here, the same as in other parts of the body, plus the influence of the respiratory acts.

In connection with this important part of the topic there are two features for the occurrence of which I desire to express sincere regret, and for one of which I am disposed to regard myself remiss; viz., the fact that of the considerable number of cases treated in two important hospitals by this method, the records were so faulty as not to entitle them to the patience of indulgent mention, especially in regard to the length of the time of treatment after the evacuation of the pus. However, in this respect my burden of responsibility is somewhat lightened by the fact that in a serial collection of 1470 cases of empyema, considered by different writers, only in a series of 75 cases (Dr. Dowd) was any reference made to the final outcome of the cases. In the instance of Dr. Dowd, however, in his collection of cases between the ages of two and fifteen years of age, he reported forty recoveries from operation in from one to three months, sixteen in from four to six months, and five cases in from six to twenty-nine months. The paucity of the number in which statements of final outcome are registered would suggest that rather too frequently than otherwise the interest in this class of patients, so far as final outcome is concerned, ends at a time not far removed from the completion of the operation for relief itself.

The cases of my own thus treated range from substantial recovery under one dressing (two) to unrecorded time in the others. The average in cases treated by this apparatus is from four to eleven weeks, the latter instance being prolonged by tuberculous complications in the lung. Usually, however, six to eight weeks are the extremes of treatment.

The practical utility of the plan is not one which I am disposed to emphasize in a startling degree as a substitute for rib resection, but, instead, to commend it because of its simplicity and effectiveness as a substitute for other measures of a similar character in instances suited to its application. The apparatus is cheap,

available, effective, easily managed even by the patient, who need never be in bed or detained in the house because of its employment. The vigor of the suction can be regulated by the size and the expanding power of the rubber bag, and the freedom of communication through the tube, which can be regulated by the position of the thumbscrew. The aspiratory influence thus exercised on an empyemic cavity is often prompt and decided, especially when the influence of expansion of the bag is not hampered with very dense fibrous exudate. The influence of negative pressure supplemented by the normal respiratory expansions rapidly diminishes the size of an empyemic cavity in many instances, especially when it is of considerable dimensions; and for this reason it should be utilized to reduce as much as possible the size of a previous intractable cavity before thoracotomy is practised. The rubber tube may be passed into the thorax through a large cannula, by means of which the fluid contents have already escaped, and the apparatus connected therewith. In cases of simple infection, and those in which, for any reason, serious operation is objectionable, or other forms of aspiration are desirable, this appliance is commended to your judicious consideration, with the hope that it may prove serviceable.

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ACUTE INTUSSUSCEPTION IN YOUNG CHILDREN.

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The consideration of intussusception in its entirety would not only require too much time and space, but would also occasion needless repetition of many phases of a subject already fully understood and duly classified. There is still an opportunity, however, for increasing the general stock of information, not only in the diagnosis of obscure cases, but also as to the indications and character of the particular method of treatment employed for its relief. In fact, the writer's attention was directed to this subject by an obscure case of enteric intussusception (Case I) in which the correct diagnosis was made only on exploration of the abdomen, and he was still further led by the fatal issue of an irreducible gangrenous intussusception in an infant (Case VI) to consider and if possible to devise some more rational method of treatment by which the excessively high mortality of resection for this condition could be materially lowered.

Of all the different varieties of intussusception the ileocecal is by far the most frequent, and almost always attacks infants and very young children. A search of the literature (if that can be used as a criterion) seems to establish the fact that it is most common in England and in the United States, less common in France, and least common in Germany. With advancing age, ileocæcal intussusception decreases in frequency and the enteric becomes more prevalent. Thus in the tabulated list of Gibson,[1] of twenty-five cases where this variety was found at operation or at autopsy, two were one year old, five between one and five years old, eight between the tenth and twentieth year, four between the twentieth and thirtieth year, one between the thirtieth and

fortieth year, three between the fortieth and fiftieth year, and one each of fifty-four and sixty-three years of age.

In a later series collected by the writer, of twenty-three cases, three were under one year old, nine between the first and tenth year, four between ten and twenty, six between twenty and thirty, and one between thirty and forty.

Smith[2] declares the frequency of enteric to be 30 per cent., but this, in the writer's experience, seems to be too high.

That the ileocecal and enteric varieties should occur most frequently in infants on the one hand, and in children and older people, respectively, on the other, seems to be accounted for by the fact that in infants the cecum is provided with a long mesentery permitting wide excursions of that viscus even as far as or beyond the anal orifice, when, as a result of exaggerated peristalsis, or from the irritation of some temporary bowel difficulty, an intussusception develops. With increasing age the cæcum becomes more and more fixed to the posterior abdominal wall, and thereby increasingly less capable of extensive movement, while the small intestine retains its mesentery, and consequently its mobility. Furthermore, infants, after the first eighteen months, outgrow the tendency to all abnormal conditions arising from faulty digestion, while as children, and after they reach adult life, they become more susceptible to intestinal polypi, enteric fever, and to the various pathological conditions associated with Meckel's diverticulum and the appendix. Thus, in the writer's series of twenty-eight cases, typhoid fever shortly preceded the development of an enteric intussusception in three, in another there was a history of typhoid fever one year previously, and in three cases an inverted diverticulum was found at the apex of the intussusceptum, viz., cases of Terry[5] Morrison,[4] and Smith.[2] In Gibson's series, already referred to, the original histories make no mention of a previous typhoid or of Meckel's diverticulum.

Of greater interest than the etiology of enteric intussusception are the different symptoms by which it is manifested. In the ileocæcal variety, a certain regularity of symptoms is observed, which usually varies only according to the extent and degree of the associated constriction. In fact, the diagnosis is probably made in most cases by the careful and experienced observer

shortly after the appearance of the symptoms of obstruction. In the enteric variety, however, the clinical picture is by no means always the same, for although repeated vomiting, at first of the stomach contents, and subsequently, where no operation was done, of intestinal contents, together with abdominal pain, seem to have been constant symptoms, yet the symptoms referable to the frequency and character of the stools vary widely. To be sure, in one case (VI) of multiple enteric intussusception, where the highest intussusception was thirty inches below the pylorus, there was one attack of hæmatemesis. Moreover, in Abbot's[3] case (Gibson series), both the vomiting and the pain occurred only after taking nourishment; but these are exceptions. On the other hand, analysis of twenty-six cases taken from both series, in which an adequate history was given, show that in eleven there was no movement of any kind, not even the passage of flatus; that in another, complete obstruction followed a single movement shortly after the invasion; that in a third a condition of obstruction was followed by bloody stools prior to the operation; that in seven cases bloody stools were observed, although in two of these cases only very small amounts were seen after an enema (possible abrasion of the rectal mucous membrane); that in another, bloody stools occurred only after the intussusception was relieved by operation, the symptoms prior to operation having been those of complete obstruction. In these same seven cases, one occurred during a typhoid convalescence, while in a similar case no mention of any stool is made, probably because operation was done six hours after the appearance of the initial symptom, for supposed typhoidal perforation. Finally, in Abbot's[3] case there was no movement for six days prior to operation, but during this time more or less constant passage of flatus was noticed.

In this same series of cases the physical examination is frequently incomplete. In six cases no tumor could be felt, possibly owing to the distention. In ten cases a tumor was present, and in all but one was situated on the right side, the sole exception being placed in the left iliac fossa. It was generally detected either just above or just below the level of the umbilicus, in one case being in the right hypochondrium, while in another it was just above and parallel to Poupart's ligament. In one recurrent

case the tumor was intermittent, while in another (where the tumor was placed in the left iliac fossa) it could be depressed and felt through the anterior rectal wall. In the writer's case the tumor was straight and freely movable (even after opening the abdominal cavity), and intermittent (it had disappeared after the administration of an anesthetic, and no pelvic examination was made). Such a free mobility of the tumor, sufficient to permit of its concealment in the pelvis, is probably due to the length of the mesentery, while its greater frequency on the right side may be explained by the oblique position of the attachment of the base of the mesentery to the vertebral column (from above down and to the right). Usually the tumor is described as sausage-shaped, namely, concavo-convex. In the writer's case it was perfectly straight, although the intussusception was eighteen inches long.

In ten cases, distention is mentioned; only in one is its absence noted. In two cases, of six and of ten days' standing, there was visible peristalsis.

Not infrequently a diagnosis of appendicitis or of perforation was made, the actual condition being revealed by operation. This was the writer's experience, where the symptoms were thought to be due to an insidious perforation, a possible appendicitis or a suppurating mesenteric gland.

On the other hand, although the symptoms of the ileocecal variety occurring in young infants do not vary widely, yet error in diagnosis and subsequent delay of operation is not infrequent, and this is not surprising, for, owing to the child's age, all symptoms are necessarily objective, and the negligent parent or the careless practitioner is led by the bloody mucous stools to diagnose dysentery. To be sure, unusual symptoms are observed occasionally, but these are generally the result of coincident multiple intussusceptions, as in a case reported by Bryant[7], of a female nine months old, where two tumors were noticed, one above the level of the umbilicus, the other in the left iliac fossa. Both tumors were movable, and although bloody mucous stools were present, no mass could be felt in the rectum. On operation, the first-mentioned tumor proved to be an ileocecal intussusception extending into the transverse colon, while the last-mentioned tumor proved to be an intussusception of the descending colon

separated from the apex of the former by four inches of empty colon.

Case I.—Referred by Dr. Tuttle. A. G., aged eight years, female. Admitted to the hospital September 6, 1905, with a diagnosis of typhoid fever. This ran the customary course, free from any complication, until the forty-eighth day, when, during the afternoon, the patient began to complain of abdominal pain, more marked in the left lower quadrant. The pain was of a griping character and intermittent. There was nausea, but no vomiting. Several hours afterward the abdomen became slightly distended, and there was moderate rigidity and tenderness over the left lower rectus. A low enema brought away some gas and several liquid yellow stools, followed by relief of the pain and disappearance of the distention. The tenderness, however, persisted. During that night, the patient slept without interruption, and was awakened in the early morning by a return of the pain and the development of tenderness to the right and just below the level of the umbilicus. In this situation an elongated oblong mass could be felt, slightly movable in all directions. At 4 A.M., the temperature was 99.6° the pulse 118. At 8 A.M., four hours later, the temperature was 98.4°, but the pulse had increased to 140. During the same interval, the general leukocytosis had increased from 12,000 to 33,000. Shortly after waking, the patient began to vomit, the vomitus consisting of the content of the stomach, and persisting at intervals throughout the day.

On examination at 2 P.M., the abdomen is symmetrical and free from distention. There is a distinct mass about three inches long and one and a half broad, below and to the right of the umbilicus. This mass has a smooth, even surface, and is very slightly tender and moderately movable from side to side. There is very little, if any, rigidity. There is no indication of either gas or fluid in the peritoneal cavity. Rectal examination negative.

Under gas and ether anæsthesia, an incision was made along the outer border of the right rectus muscle, below the level of the umbilicus. The peritoneal cavity contained at least three pints of free serous, odorless fluid. The appendix was quickly exposed, and found to be normal. The mass, which had disappeared under the anæsthetic, was found in the pelvis and easily

brought into the wound. It consisted of an intussusception of the small intestine about eight inches long, but no time was taken to determine its distance from the ileocecal valve. The intussusception was reduced by expression and slight traction, and was then fixed at either side of the point of constriction by plain catgut sutures to the edge of the peritoneum. No induration or ulcer could be felt through the wall of the small intestine at or in the area of the invagination. After reduction, the affected intestine was moderately thickened and swollen, and of a dark mottled color. In places, it had also lost its glistening appearance. There was, however, no loss of resiliency. The abdominal wound was completely closed without drainage.

There was immediate cessation of both pain and vomiting. The pulse remained from 120 to 130 for forty-eight hours and then decreased gradually to around 100. The bowels moved on the day after operation, and thereafter at regular intervals, and at no time was there either blood or mucus in the stool. The wound healed by primary union.

Two weeks after the operation, patient had two sudden, sharp attacks of pain just below and to the right of the umbilicus, with an interval of twenty minutes. There was one attack of vomiting. Examination revealed some tenderness in the area of pain. An enema brought away a number of large scybalous masses, and later a good movement took place, with complete relief of all symptoms.

Again, after another fortnight, the patient having left the hospital, a similar attack of general abdominal pain appeared after the bowels had been constipated, and the patient vomited several times. On the following day the symptoms still persisted, and the patient vomited once more. An enema, however, relieved all the symptoms. Since that time the patient has enjoyed the best of health.

In order to facilitate the discussion of the treatment of intussusception, a brief statement of its gross pathology seems desirable. Apart from its location and the possible multiplicity of the intussusception, and solely with reference to its reducibility and viability, we find conditions quite analogous to those of hernia, in that the intussusception may be completely reducible and viable, or

reducible and not viable, or irreducible and viable, while in the more advanced cases of irreducibility a condition of strangulation exists. In the latter instance, however, the resulting gangrene first attacks the intussusceptum, and although later the intussuscipiens may become involved as well, it is nevertheless quite possible for it to remain viable throughout. An interesting proof of this fact is furnished by those cases of intussusception in which recovery ensues without operation after the discharge of the necrotic intussusceptum per rectum.

In every case of intussusception, interference with the return circulation, as in strangulation from any cause, leads to the collection of a serous or of a serohemorrhagic exudate into the peritoneal cavity. This shortly afterward becomes, first, turbid, and, with the invasion of a septic peritonitis, with or without perforation, purulent.

Without any special consideration of the treatment of the subsequent associated peritonitis, the treatment of the intussusception naturally resolves itself into the treatment of the (*a*) reducible variety, (*b*) the irreducible variety, the gut being viable; (*c*) of the irreducible variety, with gangrene of the intussusceptum only; and (*d*) of the irreducible variety, with gangrene both of the intussuscipiens and of the intussusceptum.

The object of the treatment of the first-mentioned variety is reduction. This may be accomplished in favorable cases by the inflation of the bowel with air, or by the use of an enema, or by laparotomy. A statement of the relative advantages of these different methods is unnecessary. Subsequent to the introduction of aseptic methods, the inflation and injection methods have gradually been superseded by operation, for they can neither be practised without risk of rupture, nor, even when successful, do they always render a prompt recurrence of the intussusception impossible. Too frequently a partial reduction only is accompanied by a disappearance of the tumor and alleviation of the symptoms, and when subsequent operation becomes necessary, the conditions are much less conducive to the ultimate recovery of the patient. Thus, Lees and Silcock[9] report a case of a boy four and a half years old, in which the symptoms were relieved by rectal injection. Two days afterward they had recurred,

and operation demonstrated an ileocæcal intussusception. Recovery followed a resection of seven inches of gangrenous gut and end-to-end suture. The use of these measures should therefore be strictly limited to the early hours of the intussusception, and should be practised then only in feeble subjects, where the operative risk is naturally great.

Another measure to overcome the obstruction without operation, that is indicated particularly in neglected cases of several days' duration, in which irreducibility, with or without beginning gangrene of the intussusceptum, has very likely taken place, is the passage of a Nélaton's soft-rubber catheter upward through the protruding intussusceptum. This measure, naturally limited to those cases in which the intussusceptum protrudes from or can be reached in the cavity of the rectum, has not received the attention it deserves. Only one such case appears in the literature, namely, that reported by Ouvry,[8] in an infant of nine and one-half months. There had been an acute onset, and the patient had become gradually worse, until, on the fourth day, the pulse was imperceptible and there was general distention. The intussusceptum was in the rectum. The catheter was introduced carefully, and on reaching a depth of from 8 to 10 cm., there was an escape of fetid liquid material and gas. At a depth of 25 cm. the catheter reached the neck of the invagination. With its passage, gentle saline irrigation was combined. One hour afterward the child nursed, and the pulse became stronger and decreased to 120. At the thirty-sixth hour, spontaneous reduction took place, and the infant recovered without operation.

Such a brilliant result could not always be expected, for the introduction of the catheter might frequently fail, and when successful, the obstruction might not be relieved nor subsequent spontaneous reduction take place. Even in Ouvry's case, in which, from his statement, the condition of the child was such as to promise little hope of success, in the absence of all intervention recovery might possibly have followed the later discharge of a sloughy intussusceptum through the rectum. Nevertheless, such success, even in only one case, seems to warrant a trial of this method, for it would require very little time and would in no way either interfere with or delay subsequent operation.

In cases of early diagnosis, operation undoubtedly affords the best results. It is needless to emphasize the importance of operating at as early a stage as possible, for each hour of delay decreases the patient's powers of resistance and increases the difficulty of reduction, while the increasing distention unduly prolongs the operation, and may subject the patient to the shock of a partial or complete evisceration.

The operation is usually done under chloroform. The location of the incision seems to vary very considerably. A mid-incision either above or below, or both above and below, the umbilicus is advocated by some, while others prefer an incision along the outer border of the right rectus. The writer prefers the mid-incision both above and below the umbilicus, of sufficient length to admit the hand, for the reason that it not only permits a rapid diagnosis when the intussusception is near the splenic flexure (a diagnosis not easily made through an incision below the umbilicus only), but also for the reason that it facilitates, in all cases, every stage of reduction under the eye of the surgeon.

On opening the peritoneal cavity, the fluid is evacuated and search is made for the apex of the intussusceptum, to either side of which a pad is introduced, and while coils of intestine are held in place, the tumor is gradually delivered to the level of the abdominal incision. This search for the nature and location of the obstruction is facilitated by the presence of a mass, and by the fact that very frequently within the first twenty-four hours after the invasion the larger part of the small intestine is collapsed. Thus Barlow[10] mentions in two cases of the ileocæcal variety, and McGregor[11] in one case of the colic variety, a collapse of about one foot of the small intestine a short distance above the point of constriction (prior to reduction). In Cases III, IV, and V, reported by the writer, this same condition was noted, although in the last two instances it was much more extensive and involved the larger part of the small intestine. In explanation of its occurrence, the theory may be advanced that distention occurs with incipient paralysis of the intestinal muscle fiber, which, as long as it continues active, naturally expels the intestinal contents away from the point of obstruction.

Reduction of the intussusceptum is now accomplished by expression, the apex of the intussusceptum being constantly kept

in view as it is very gently compressed by the fingers of the surgeon toward the cæcum. The early part of reduction is almost always easily accomplished, and it is not, usually, until the cæcum itself is approached that any difficulty is experienced. At that stage, the writer does not agree with the opinion that expression should be still further continued without any assistance from traction of the intussusceptum. Expression too energetically applied is as certain to rupture the intestine as is excessive traction. While both extremes should be avoided, material assistance was afforded by gentle traction in Cases I, III, and IV, here reported, without damage even to the peritoneal coat of the invaginated gut.

After reduction has been satisfactorily accomplished, some step should invariably be taken to prevent either immediate or remote recurrence of the invagination. The writer knows of at least one instance in which, in the absence of this precaution, rapid recurrence took place, with a fatal termination. That late recurrence is also possible is shown by the case reported by Power,[12] of ileocæcal intussusception in an infant, where two operations were done, two months intervening, ultimate recovery taking place. In late recurrences, however, the second attack is not always of the same variety as the first. Thus McGregor[11] reports a case in which the patient was operated on twice during the year for intussusception. The first attack proved to be an ileocecal variety, while the second was enteric. The same writer reports a second case, in which, after an ileocecal intussusception, the recurrence proved to be of the colic variety. It is not just, however, to maintain that, in every case of intussusception, a recurrence can be averted by the exercise of any one of the different measures suggested for that purpose, although at the same time a search of the literature has failed to reveal any instance of recurrence under those circumstances. Inasmuch, however, as such a step does not materially lengthen the operation, it is advisable to carry out some measure that will render recurrence less liable, by limiting the freedom of mobility of the cæcum or of the small intestine.

McGregor suggests a reef in the mesentery and mesocolon, a measure which seems to incur the possible risk of interference

with the circulation of the corresponding gut. Chiene,[13] in a case of ileocecal variety, sutured the mesentery of the terminal portion of the ileum to the wall of the cæcum in such a way that the end of the ileum made an acute angle with the vertical axis of the ascending colon. The writer, in Cases I, II, III, IV, and V, merely sutured the gut both above and below the point of constriction to the anterior or lateral parietal peritoneum.

The removal of a Meckel's diverticulum in the enteric variety is always indicated, while an appendectomy by some is also believed to diminish the chances of recurrence in the ileocecal variety.

Before the closure of the wound a rapid search should be made for possible intussusception in other parts of either the large or small intestines, and if any are found, they must be treated by the same method as that just described. Ordinarily, after possible saline irrigation of the affected loop, the abdominal wall is closed without drainage. The writer's Cases II, III, IV, and V, histories of which follow, present the ordinary features of reducible intussusception.

Case II.—Referred by Dr. Lee. J. N., male, aged two years and ten months. Admitted to the Presbyterian Hospital, May, 1903. Child has always been strong, and free from all kinds of sickness. Thirty-six hours before admission, vomiting appeared and has persisted since at increasing intervals, the vomitus consisting of the contents of the stomach and afterwards of bile and mucus. During this same time there has been occasional discharges of small quantities of blood and mucus from the bowel. There has been increasing prostration and general abdominal pain.

Physical Examination. The abdomen is slightly distended; the child strong and vigorous, and in good general condition. There is a sense of fulness in the lower right quadrant, with moderate rigidity and tenderness. In this same area there is dulness as far as the outer edge of the right rectus muscle. Peristaltic activity is far more active on the left than on the right side of the abdomen. On rectal examination no mass can be felt. Pulse ranges around 120; the temperature about 102°.

Immediate operation under chloroform anesthesia. Median

incision from one inch above the umbilicus to the symphysis pubis. The peritoneal cavity contained a large amount of clear serous fluid without odor. The small intestine was much distended and congested; the large intestine collapsed. An intussusception of the ileum about twelve inches above the ileocecal valve was found, and reduced by expression. The gut was viable, and was sutured on either side of the line of constriction to the parietal peritoneum. Complete closure.

After the operation the vomiting entirely ceased; the bloody discharges per rectum disappeared. Fluid stool took place on the day following the operation. The pulse gradually diminished to 88 at the time of discharge. Primary union.

Three years after the operation the patient is robust, and has never had a return of the intussusception.

Case III.—J. K. C., male, aged eleven months. Admitted to the hospital October 4, 1905. The patient is a vigorous child, and had always been well until yesterday noon. At that time the patient doubled up as with severe abdominal pain, crying out, and shortly after had several attacks of vomiting, the vomitus consisting of the contents of the stomach. Towards evening the child seemed to strain, and passed small amounts of blood and mucus in the stool. These were repeated at intervals during the night. On the following day the vomiting was repeated, the bloody stools continued, and the child was evidently considerably prostrated and rapidly growing weaker.

On examination, the abdomen was prominent and slightly distended. An oblong curved tumor extending from the median line above the level of the umbilicus downward and to the left could be distinctly felt. It was sausage-shaped and moderately tender. There was no shifting dulness or fluid wave. On rectal examination the apex of the intussusceptum could be felt a short distance above the anus. Pulse was 135, temperature 102°, and respiration 36.

Immediate operation. Under ether anæsthesia, the peritoneal cavity was opened by an incision both above and below the umbilicus. It contained a small amount of serous odorless fluid. The mass forming the intussusception was easily recognized and brought into the wound, where it was reduced by expression,

assisted at the end by slight traction. It was of the ileocecal variety; after reduction, both the caput coli and the appendix were markedly congested. The cecum and small intestine were sutured to the parietal peritoneum on the right side of the incision, and the abdomen completely closed without drainage.

Only one attack of vomiting occurred after the operation. The bloody stools ceased, but after the first day they were green and offensive for a time. The temperature on the first day was 104°, on the second day it had dropped to 102°, and thereafter gradually decreased to normal. The pulse had diminished to 100 on the second day. The child nursed from the mother throughout the entire time. Primary union was secured.

Case IV.—A. Q., female, aged six months, admitted to the hospital April 3, 1905. This morning, about ten, patient has an attack of convulsions. At eleven was seized with repeated vomiting, consisting of the contents of the stomach and afterwards of bile, and simultaneously with the vomiting the bowels moved a number of times, each movement containing blood and mucus. Patient refused all nourishment.

Physical Examination. There is some rigidity of the right side of the abdomen opposite the level of the umbilicus, with moderate tenderness and a sense of a mass. There is no distention and no evidence of fluid in the peritoneal cavity. Rectal examination was negative.

Operation eight hours after the invasion, under chloroform anæsthesia. Under the anæsthetic a sausage-shaped tumor was felt just to the right and slightly above the level of the umbilicus. The peritoneal cavity, opened through a three-inch median incision extending equally above and below the level of the umbilicus, contained but little fluid. Almost the entire length of the small intestine presented a collapsed appearance, except directly above the intussusception, where it was moderately distended. The apex of the intussusception was found in the descending colon, and reduction was easily effected by expression, aided by slight traction near the end of the manœuvre. Suture of the cæcum to the parietal peritoneum. The intussusception was of the ileocecal variety. Complete closure. Duration of the operation, seventeen minutes.

There was no reaction or vomiting. The child took nourishment the following day without difficulty. On the third day after operation there were several dejections containing mucus and blood. Thereafter the stools were normal. Primary union was obtained throughout the entire incision.

CASE V.—H. M., male, aged two years. Admitted to the hospital April 3, 1905. Patient is a poor subject, having been treated in the dispensary of the Presbyterian Hospital for rachitis and general functional intestinal disturbances for the past eight months. For the past forty-eight hours patient has suffered from abdominal pain and from repeated attacks of vomiting, with occasional bloody stools. The general condition is poor.

Physical Examination. There is general abdominal distention and rigidity. Slightly to the left and above the level of the umbilicus a sausage-shaped mass could be felt, which, after the administration of the anæsthetic, became more distinct. On rectal examination the apex of the intussusceptum could be felt within the anal margin. Pulse 130.

Immediate operation, under chloroform anæsthesia. Median incision above and below the umbilicus. There was a slight amount of clear fluid in the peritoneal cavity. The mass forming the intussusception was brought up to the level of the abdominal incision and rather easily reduced by expression, the latter part only returning with some difficulty. The larger part of the small intestine was collapsed, the distention beginning about two feet above the site of constriction. After reduction had been accomplished, a general enlargement of the mesenteric glands was noticed, especially in that part corresponding to the lower part of the ileum. The small intestine and cæcum were stitched to the parietal peritoneum and the wound completely closed, the entire operation taking twenty minutes.

After the operation there was restlessness, with a gradual increase in the rapidity of both pulse and respiration. One dejection, streaked with blood, occurred two hours afterwards, but the general condition of the patient gradually became worse and death took place in six hours.

No autopsy was permitted.

The element of irreducibility introduces a serious complication

in the operative procedure. It is interesting to note that in some exaggerated cases excision of the irreducible mass has been accomplished through the rectum. Thus Westbrook[14] cites a case, in an infant six months old, where, after a week's duration, physical examination revealed the apex of an intussusceptum protruding through the rectum. This was removed by the cautery. An examination of the specimen showed it to consist of a "considerable part of the ileum and colon." "The patient convalesced but died four weeks later of gastroenteritis. No autopsy." Also, Petit[15] mentions a resection of sigmoidal intussusception, that was mistaken for a polyp, through the rectum. Grisel[16] states that, to his knowledge, only two cases of intussusception in infants treated by resection recovered. In one, that by Fisk, no mention could be found in the literature. The other, by Grosz, proved to be a case of resection of an intussusception through the rectum.

The method of removal of irreducible intussusception through the rectum can be practised in only exceptionally favorable cases of the ileocecal and colic varieties, but is necessarily excluded as a therapeutic measure in all enteric, ileocolic, and colic varieties in which the apex of the intussusceptum lies within the lumen of the gut. Under these circumstances (and many will think it true, as well, of all cases where the intussusceptum protrudes from the rectum) the condition of irreducibility can be treated satisfactorily only by laparotomy, the particular means of dealing with the pathological condition depending upon the question of viability of the inner and outer cylinders of the gut. If both are viable (and this, the writer believes, is a rare condition), Bell[17] recommends, theoretically, a division of the constriction as in paraphimosis. This permits of reduction, and leaves a linear incision of the gut, which can be quickly closed by the Czerny-Lembert method. Such a procedure would be useless in case of gangrene of either one or both cylinders, for, in each instance, it would unnecessarily increase the risk of a subsequent septic peritonitis.

Another operative procedure, suggested by Richardson,[18] consists in making an enterostomy above the site of constriction. Enterostomy, however, seems to afford relief only in very few instances,

and, owing to the excessive mortality associated with it, is scarcely to be advocated as a routine measure.

The group of cases in which the entire intussusception is gangrenous must be relieved by complete resection, it lying in the judgment of the surgeon to determine whether the divided ends are to be left *in situ*, or whether an attempt shall be made to reestablish the continuity of the intestinal canal. In any event, the patient, if a child or an infant, rarely if ever survives. It must be remembered, however, that complete gangrene occurs only in extreme cases of constriction, and that the group of cases in which the outer cylinder is viable is much more common, although, unfortunately, the mortality after operation for its relief seems thus far to have been equally high. In an attempt to devise a method by which this extreme mortality could be lowered, the writer has thoroughly searched German, French, English, and American literature, together with references and abstracts of monographs in other foreign languages, and has found therein the following various methods of treatment:

1. Enterostomy. Made usually above the point of constriction, occasionally below that point, near the apex of the intussusceptum.

2. Resection.

(*a*) With artificial anus and subsequent restoration of the lumen of the canal.

(*b*) With immediate restoration of the lumen of the canal.

(*c*) By Barker's method.

(*d*) By Mikulicz's modification of Barker's method, consisting of the resection of the intussusceptum through an incision in the intussuscipiens, the edges of which have been first sutured to the edges of the parietal peritoneum so as to make an artificial anus. In this way infection of the general peritoneal cavity was avoided. Mikulicz[19] reported two cases treated in this way, of subacute or chronic intussusception in adults, both of which recovered. The writer has found no statement of the trial of this same method in acute cases in infants, and thinks that the length of time necessary to carry out the different steps of the operation in such tender patients might invalidate what certainly is a most ingenious procedure.

The excessively high mortality of any of these procedures (other

than the untried method of Mikulicz) is clearly demonstrated by the following brief statements.

Rosenthal[20] has collected twenty-five cases of irreducible intussusception. In twelve cases only one survived, an adult of thirty-five with chronic intussusception; of nine enterostomies, all died.

Nelson[21] reports a case of enterostomy at the apex of a gangrenous irreducible intussusception, in a child of eight, the operation being done on the fifth day of the attack. Immediate improvement followed, with intermittent discharge of gangrenous intestine for eight days, through the enterostomy orifice. Then a recurrence of the obstructive symptoms took place, with distention and vomiting. A resection was then done, and was followed by the prompt death of the patient.

Cordica[22] has collected twenty-three cases of resection in infants and children, of whom twenty died and three recovered, the successful cases being seven, nine and eleven years old, respectively. Of the twenty deaths, eleven were operated on since 1890. Of nineteen cases of enterostomy in children, all died within twenty-four hours of the operation; of these, eleven were under one year, four were between one and two, and the others were somewhat older.

Grisel[16] has collected eighteen cases where an artificial anus was made, with two recoveries.

Cordica[22] reports a case of resection of a completely gangrenous intussusception of the lower part of the small intestine in a girl of four. The resected ends were left in the wound, and after several weeks, during which time the child was nourished with difficulty, an end-to-side anastomosis was performed, the ileum being implanted in the sigmoid, which had become shrunken to the size of a lead-pencil.

The writer has collected, including his own, fourteen additional cases of resection and three enterostomies. Of these, the majority were infants under one year, with only one recovery. This was a case reported by McDonnell,[23] of the enteric variety, in an infant ten months old. On operation, fourteen hours after the onset, reduction was accomplished. There remained, however, a suspicious area of the small intestine, which was left exposed and which, at the end of the eighteenth hour, had proved gangre-

nous. Three inches of the intestine were then resected, followed by end-to-end anastomosis by suture, with a glass drain for twenty-four hours, the patient making an uneventful recovery. This was not, however, either an irreducible case or one of the ileo-cæcal variety; two most important factors, for, owing to the first, the intussusception had been of comparatively short duration, and therefore the powers of the patient had not become entirely exhausted, and, owing to the second, the restoration of the continuity of the intestine was facilitated by the fact that the resected ends were of the same caliber. Nevertheless, it was the only case of recovery which the writer was able to find in an infant under one year.

In older children, on the other hand, recovery has taken place, although infrequently, and, as in the case of the infant just cited, the intussusceptions have always been of the enteric variety. Of these, Dowd's[24] case, in a child of four years and four months, deserves mention, and is of interest because of the comparatively long time intervening (ten days) between the invasion and the operation. The ends of the intestine were brought together by circular enterorrhaphy and the abdomen was closed without drainage.

Barlow,[25] reports a case, in a child of ten, of four days' standing, of enteric intussusception, in which, at the time of operation, a purulent exudate into the peritoneal cavity was found. Here, after resection, the ends were united by a Murphy button in an end-to-end anastomosis, and after flushing the peritoneal cavity with saline solution a glass tube was introduced and the wound closed. Recovery was impeded only by a stitch abscess. Cordica's case, in a patient of four, has already been mentioned.

Of the fatal cases published during the last few years, the resected ends have been united by the end-to-end method, with both suture and button, by lateral anastomosis after closure of both ends, and by the end-to-side method after closure of the distal end. As yet, no successful case has been published of resection for an ileocecal intussusception in an infant under one year in which the continuity of the gut has been re-established, and only a single case of the enteric variety where the patient was not yet a year old. That some similar measure must be followed in cases

where the entire intussusception is gangrenous, is undisputed. The operation should be conducted as quickly as possible, and the continuity of the intestine should be restored by rapid suture. Even under the most skilful manipulation, recovery will always be a rare occurrence. When only the intussusceptum is gangrenous, however, cannot better results be achieved than by resection? In a small proportion of these cases, nature, unassisted, effects a cure by the separation and ultimate discharge of the intussusceptum through the rectum. Is it not possible for the surgeon to assist this process, and to facilitate the separation and discharge of the necrotic material, while at the same time means are provided for the relief of the obstruction? Barker, some years ago, reported a series of cases, in which a resection of the intussusceptum was attempted through a linear incision in the intussuscipiens. This, however, is very difficult to accomplish without soiling the peritoneal cavity, and the intraintestinal ligation of the mesentery is fraught with a very considerable risk of hemorrhage. In fact, not a single recovery is cited in cases treated by Barker in this way. The method of the late Mikulicz has already been mentioned and has the advantage of avoiding the risk of peritoneal contamination. Although two successful cases by the author of this method are reported in adults, no case similarly treated in an infant has as yet, to the writer's knowledge, been published. In fact, it is questionable whether the relatively longer time necessary for this form of operation, together with the uncertainty of satisfactorily ligating the friable if not gangrenous mesentery, might not make it of less value in acute intussusception of infants than in the chronic intussusception of adults.

The following plan occurred to the writer in connection with Case VI, and although the method, as suggested, is as yet untried, yet the very high mortality of resection seems to be a sufficient excuse for offering it as a substitute at this time.

After opening the abdominal cavity, the intussusception is identified, and reduced as far as possible without the use of either excessive or unduly prolonged effort of expression or traction. The small intestine is then sutured at its point of entrance to the margin of the intussuscipiens by several interrupted silk

sutures extending through the serous and muscular coats. These sutures insure the formation of sufficient adhesions between the viable part of the bowel to prevent extravasation of intestinal contents, when nature subsequently separates the sloughing intussusceptum from the adjacent viable gut. The entire intussusception is now returned into the abdominal cavity, with the sole exception of that portion corresponding to the apex of the intussusceptum. At this point, suitably protected by pads and held up by a pair of silk ligatures, the intussuscipiens is opened longitudinally, exposing the apex of the intussusceptum. A soft rubber or silk catheter is then passed, if possible, through the intussusceptum, beyond the constriction, into the bowel above, the escape of the accumulated fecal material and gas being prevented temporarily, until the edges of the divided intussuscipiens and the parietal peritoneum are united, by placing a clamp on the catheter. In this way the obstruction may be relieved until the patency of the intestine is again restored by the discharge of the intussusceptum either through the opening in the intussuscipiens or through the rectum. That the passage of the catheter in the manner described is feasible was demonstrated in the autopsy of Case VI, where it passed without difficulty beyond the constriction, as well as in the case of Ouvry and in a similar case that was recently observed by the writer in the living subject. If the passage of the catheter is unsuccessful, an enterostomy made in the manner described would facilitate the ultimate discharge of the sloughy intussusceptum.

In conclusion, the serious character of all neglected cases of intussusception cannot be too strongly emphasized, as well as the fact that any method of treatment is likely to be unattended with success. Hence the surest relief is afforded by early and prompt operation, while the intussusception is still in a reducible condition and while the resistance of the patient is sufficient to withstand successfully the shock of a laparotomy.

Case VI.—F. C., male, aged seven months. Admitted to the hospital November 4, 1904. Three days ago, the infant, who had always been perfectly healthy, was thought to be sick, because it cried a good deal. Two days ago, the bowels moved for the last time, although cathartics were given since. For the past

thirty-six hours there has been persistent vomiting, which, at the time of admission, had a fecal odor. During this same time, there had been occasional discharges of blood and mucus from the rectum. The general condition of the patient is very poor, and the pulse is 140 and feeble.

Physical Examination. The entire abdomen is slightly distended and moderately rigid. There is general tympany and no evidence of shifting dulness. No tumor could be felt. There is a moderate amount of visible peristalsis. Rectal examination was negative, an enema failing to bring away either gas or fecal material.

Immediate operation, under chloroform anæsthesia. Median incision from umbilicus down to the symphysis pubis. The peritoneal cavity contained turbid free serous fluid. After partial evisceration, the apex of an intussusception was found at the splenic flexure, and was partially reduced by expression until the tip of the vermiform appendix became visible. All further efforts at reduction were fruitless, however, and an opening was made in the distended small intestine just above the point of constriction and stitched to the edge of the divided peritoneum. Partial closure.

The patient died six hours after the operation from shock, the enterostomy having discharged a considerable amount of fecal material.

Autopsy. The intussusceptum was gangrenous, and could be reduced only after the division of the intussuscipiens for a distance of several inches on either side of the constriction. Before this was done, however, a soft rubber catheter was easily passed through the apex of the intussusceptum into the small intestine above the point of constriction.

Case VII.—J. J., male, aged nine months, July 5, 1900. Child was fed on breast alone for five months, then on breast and bottle for six weeks, then by bottle alone up to the present time, the food consisting of a dram of cereal to a pint of boiled milk. For the past six days the child has been restless and sleepless, and inclined to vomiting after taking nourishment. Three days ago, blood was noticed for the first time in the stool, there being a bloody discharge once an hour for eight hours, then at longer intervals

up to the present time. There has never been any mucus, but the bloody stools have been mixed with considerable foul material, and with "lumps looking like raw meat." The vomiting has increased in frequency for the past thirty-six hours, and to-day acquired a fecal odor.

Physical Examination on Admission. The child looks sick. Extremities cold. Heart rapid, but regular. The abdomen is generally distended. There is general rigidity, which is more marked in the left lower quadrant, where a distinct oval mass the size of a lemon may be felt extending down toward the pelvis. The apex of the intussusceptum can be felt per rectum two inches above the anus. Small amount of blood on the examining finger.

Immediate operation. Chloroform. The peritoneal cavity was opened through a vertical incision four inches in length, below the level of the umbilicus, just to the left of the median line. After partial evisceration, the small intestine being greatly distended and cyanotic, and held with difficulty in the abdominal cavity, the intussusception was reduced by expression through the large intestine to a point about ten inches above the ileocæcal valve. At this point four inches of the small intestine were gangrenous, and perforation had already occurred. Resection of eight inches of small intestine, with end-to-end suture, by means of Murphy button. Closure with gauze drain.

Child died four hours after operation, not having recovered from the shock.

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THE USE OF THYROID EXTRACT TO SHORTEN COAGULATION TIME OF THE BLOOD.

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It is not my intention to present an elaborate paper upon the effect of thyroid extract upon the general circulation, or to go deeply into the theoretical reasons for its administration, but simply to present a short note upon its internal administration as a means of shortening the coagulation time of the blood, and to suggest that it be given a careful trial in all cases where surgical operation is absolutely necessary or where injury has occurred in hemophilics, as well as in patients whose blood has been altered by disease.

All of us know with what feelings of apprehension surgical operations are undertaken in persons of a hemorrhagic diathesis, and in those profoundly jaundiced from obstructive disease of the bile passages, and with what serious consequences even trivial wounds may be followed. Indeed, J. Weckham Legg (Allbutt's *System of Medicine*, vol. vi, p. 548) goes so far as to say that in hemophilics it is "hard to imagine a case in which the use of the knife would be justifiable."

Blood which is normal, and by this I mean blood which has the proper amount of coagulating element, is not affected by the administration of thyroid extract, even when this has been continued for a long time and when the constitutional effects of its use have been so pronounced that it must be discontinued. It seems to act only upon blood which lacks that which has been called fibrin ferment. This is well shown by a patient of Dr. John K. Mitchell, an old case of poliomyelitis, who was enormously fat and, beyond palsy of her lower limbs, in perfect health.

Very careful tests were made of her blood by Dr. W. B. Cadwalader every few days for nearly three weeks, during the whole of which time she was taking five grains of thyroid extract three times a day in the hope of diminishing her weight. Owing to its action upon her heart its administration was discontinued, but there was no appreciable effect upon the coagulation time of the blood. This has been confirmed by Dr. J. C. Da Costa, Jr., in a series of examinations which he made of normal blood of patients to whom thyroid extract had been administered for various therapeutic reasons. All this would show that when the blood contains the normal amount of fibrin ferment no effect is obtained whatever, either good or bad; but when this element is markedly diminished, it supplies it either by a direct action upon the blood or, as Dr. C. E. de M. Sajous thinks, by stimulating the anterior pituitary body. He, Dr. Sajous, considers that the secretion of the adrenals on reaching the lungs becomes converted into an oxidizing agent, *i. e.*, the albuminous constituent of the hæmoglobin molecule. This substance he finds identical both with the "oxidase" of the French chemists and fibrin ferment in its reactions, coagulating temperate, etc. and that when the functional activity of the adrenals is enhanced the volume of the fibrin ferment in the blood is increased, which ferment by uniting with fibrinogen endows the latter with its coagulating property. He contends that the governing center of the adrenals is the anterior lobe of the pituitary body and that this is kept active by the internal secretion of the thyroid. He believes that in administering thyroid extract we stimulate the anterior pituitary body, which in turn excites the adrenals to greater activity, and thus the proportion of fibrin ferment in the blood is correspondingly augmented and its coagulating power is increased.

A. E. Wright (*Brit. Med. Journ.*, July 14, 1894, p. 57) states that the coagulation time of the blood is lengthened by starvation and shortened immediately after a hearty meal, and (*Lancet*, February 25, 1893) that the efficiency of the action of calcium chloride can be augmented by combining it with a solution of cell neucleo-albumin, that is, with an albuminous substance which can be obtained from aqueous extracts of cellular tissue, such as the thymus, thyroid, testicle, and gastric and other mucous

membranes. He considers that the basis for rational therapeutics in hæmophilia, and the treatment of all cases of hemorrhage and aneurysm which are not accessible to surgical treatment, should be in increasing the coagulability of the blood.

Wachenheim (*Med. News*, January 16, 1904, p. 114) in an elaborate article states that the characteristic symptom of hemophilia is not spontaneous bleeding but defective coagulation and, as he calls it, a "toxinemia with secondary auto-immunization to a quasi normal function."

While perfectly willing to admit that surgical operations should not be undertaken in these cases, unless the condition is one which imperatively demands it, and thoroughly appreciating the great danger and even fatal bleeding which may occur, there are certain conditions and accidents met with in these unfortunates which demand treatment at our hands. It is for this reason that I bring the subject before you in the hope that this method of administering thyroid extract as a definite preparatory treatment to surgical operative procedures may prove of value in cases in which the coagulation time of the blood is greater than normal.

It has been stated by Fordyce (Stengel, "Diseases of the Blood," *Twentieth Century Medicine*, p. 520) that large wounds sometimes prove less dangerous than slight injuries, and that enlargement of small wounds by free incision has at times served to check hemorrhage in these unfortunate cases.

A year ago I had under my care a woman of thirty-eight who had all her life been a bleeder and who suffered intensely for many years from a movable kidney. She had constant pain, was unable to walk, could not be comfortable in bed, and had repeated crises in which there was suppression of urine with hydronephrosis and accompanied with evidences of uremic intoxication. The urine at times was loaded with blood and with other evidences of intense congestion. The condition was so serious that an operation to fix the kidney in place was urgently demanded. For many years she had bled profusely from the simplest wound. Furious and persistent bleeding had followed, some years before, an operation upon her nose, and about two years before she had bled from nearly all of her mucous membranes and had had a

series of purpuric spots in various parts of her body. As is usual in these cases the menstrual flow was not abnormal. The coagulation time of the blood when first seen by me was eleven and a half minutes, and the needle prick of the finger bled for hours and was only controlled by pressure. The hemoglobin was 70 per cent., the red cells 3,350,000 and the whites 5600.

Under careful and systematic treatment by iron, malt, massage and feeding and, at Dr. Sajous's suggestion, the administration of three grains of the dried thyroid extract three times daily, the coagulation time of the blood was shortened from eleven and a half minutes to three minutes and four seconds.

Operation was about to be undertaken when, from causes other than those connected with her physical condition, it was necessary for a postponement. Six weeks later thyroid extract was again given for four days and the coagulation time was found to be two minutes and six seconds. The next day an incision was made in the loin and the kidney fixed in place by means of sutures passed through dense adhesions which were found attached to the kidney as the result of former inflammation, but no sutures were passed through the kidney structure. The wound was remarkably dry, there being much less oozing than is usual in such operations and she made a prompt and normal convalescence. Indeed it was the dryest wound I have ever seen in such an operation.

The second case in which it was tried was that of a boy of eighteen, a bleeder and of a family of bleeders, upon whom I operated for necrosis of the fibula following an osteomyelitis, and until after the operation I did not know of his hemorrhagic tendency. The wound bleed for weeks, the dressing being saturated continuously and showed no disposition to heal, while the granulations were large, intensely congested and bled on the slightest touch. Nothing in the way of treatment had any effect until he was given thyroid extract, when the improvement was immediate and most marked, and by the end of a week all bleeding had ceased from the granulations and the wound began to heal rapidly, although no change had been made in the materials used in the dressing nor any other form of internal medicine employed. It is to be regretted that at this time no coagulation tests were made.

The third case was of a woman aged forty-five years, who had been a bleeder all her life, and who eight years before had bled from the gums for forty-eight hours after the extraction of a tooth. She was subject to severe epistaxis at frequent intervals, and bled freely from her gums at all times from the slightest scratch. Fear of bleeding had prevented her for years from having two teeth extracted, but after she had taken three grains of thyroid extract for three days the teeth were pulled. She had no trouble whatever in spite of the fact that the gums were badly lacerated by the dentist in his efforts to get at the roots of the teeth. There was no more bleeding than could have been considered normal.

These three cases were all unmistakable bleeders, possibly not true hæmophilics, but undoubtedly of a hemorrhagic diathesis and the remarkable results following the administration of thyroid extract can only be attributed to its influence. In the first and third instances hemorrhage would have been, almost certainly, a dangerous complication, and in the second the sudden cessation of the oozing from the wound could only have been due to its influence.

The only record I have been able to obtain of the use of thyroid extract in profound jaundice is that of a case of Dr. Richard H. Harte, who has very kindly given me permission to report it.

The man, a miner, was thirty-seven years of age, and had been in the Pennsylvania Hospital in 1904 with a history of subacute jaundice and slight hemorrhages from the mouth and bowels. Cholecystotomy was performed by Dr. James P. Hutchinson, who found no stones but the gall-bladder was drained. There was free bleeding at the time of the operation and afterwards. Jaundice and bleeding from mucous membranes continued for a year and, on May 8, 1905, his blood was examined and its coagulation time was found to be four and one-half minutes. On June 2d the coagulation time had lengthened to twelve and one-half minutes. He was now given three grains of thyroid extract three times a day with the result that the coagulation time was steadily shortened, as in seven days it was seven and one-half minutes and in thirteen days only six and one-half minutes. The jaundice was not relieved, and death occurred from carcinoma of the hepatic duct with hypertrophic cirrhosis of the liver and

duodenal ulcer. Dr. Harte opened the abdomen, but nothing could be done owing to the nature of the disease, and during the operation there was some hemorrhage but this was not unusual in amount.

The results in this case in shortening the coagulation time of the blood from twelve and one-half minutes to six and one-fourth, or a little over one-half, without there being any change in the intensity of the jaundice, is certainly interesting and would suggest that a more extensive trial be made of it in other cases.

Mayo Robson has great confidence in the results obtained in these cases of jaundice from the administration of calcium chloride and employs it as a routine measure of treatment, but in the hands of others its action is not so satisfactory, and many surgeons of large experience have ceased to employ it.

If, as I think possible, thyroid extract will cause shortening of the coagulation time in these cases by materially increasing the fibrin ferment, it will prove of great value as a practical method of diminishing the dangers from persistent bleeding in these cases.

I have not yet tried Wright's suggestion of combining the administration of calcium chloride with an albuminose, but when very rapid effect is desired it would seem to be the best plan to be pursued, and the drug should be given at the same time as the thyroid extract.

Method of Employment. In all cases of suspected or probably delayed coagulation the blood should be carefully examined, its coagulation time accurately noted, by Wright's apparatus or that of Brodie and Russell, which Murphy and Gould (*Boston Med. and Surg. Journ.*) consider the most accurate, or even by the drop method with a warmed glass slide. Several tests should be made from blood taken from various portions of the same patient's body. Delayed coagulation with its probable want of fibrin ferment being established, dried thyroid extract should be given in three-grain doses in capsule three times a day after meals.

The blood should be tested daily if possible, and usually the effect of the treatment should be noted within forty-eight hours. Its action upon the heart should be watched, and its depressing influence be counteracted by full doses of strychnia.

Its value in controlling hemorrhage from various regions in the body, which are due to systemic conditions of relaxation and not to local causes, is well known and is being more widely employed.

Its action in uterine hemorrhage, purpura and bleeding from the gum and in scurvy, is now very generally known.

Thyroid extract has been used with great good effect in several cases of purpura with spongy and bleeding gums, in typhoid fever where all other methods of treatment had been ineffectual.

Whether further experience will confirm these observations can only be conjectured; but certainly in my own cases the results have been so marked and constant that I propose in every case of delayed coagulation, particularly when associated with a history of frequent bleeding, to give thyroid extract until its value as a therapeutic measure is established.

The methods employed of testing the blood of all of these patients has been that of A. E. Wright, which is very troublesome and requires a long time to complete. I wish here to acknowledge my indebtedness to Dr. Frederick Fraley, Jr., and to Dr. Arthur Newlin for their aid, as these examinations were made by them.

Murphy and Gould (*Boston Med. and Surg. Journ.*, July 14, 1904, p. 45), in a series of six hundred examinations of the blood to test its coagulability, recommended the method of Brodie and Russell. They state that errors of technic are very easy and the results may therefore fail for various causes and that Wright's method failed to give results in their hands in 15 per cent. of the observations, while that of Brodie and Russell (*Journal of Physiology*, 1897, xxi, p. 403) failed in less than 5 per cent. of their examinations. They made examinations of the blood in fifteen cases of jaundice from various causes, gall-stones, catarrhal jaundice, cholecystitis, cirrhosis of the liver, cancer of the liver, cancer of the head of the pancreas, and chronic pancreatitis, but failed to find that coagulation varied from the normal. This is certainly very interesting and instructive, and must be considered in estimating the value of this method of treatment, as it proves that delayed coagulation is not constantly associated with jaundice due either to benign or malignant obstruction.

Weil (*Presse Médicale*, Paris, 1905, No. 83) has employed intravenous injection of beef serum with marked results in shortening

the coagulation time of the blood in hemophilics, and recommends the serum treatment as a preventive measure in case an operation is contemplated upon a hemophilic.

My object in writing this short paper is merely to place on record my own observations, and in the hope that the Fellows of this Association may deem the subject of sufficient value to test it in a large series of cases.

EXCISION OF SCAPULA FOR MALIGNANT GROWTH.

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The classical monograph of J. J. Buchanan, of Pittsburg,[1] has brought the literature concerning scapular excision up to so recent a date, and is so complete, that it would be carrying owls to Athens to attempt to rearrange the statistical data even to the extent of adding additional cases with a view to formulating rules for our guidance in performing the operation. As von Adelmann[2] has said: "From the descriptions of the manifold operations I am convinced that in each case it must be left to the intelligent operator to formulate a plan of operation according to the circumstances of the individual case and to execute it, *mutatis mutandis*. The unyielding encheireses as given by different authors are to be found in the hand-books on operative surgery and may be applicable in cases of necrosis, but are useful for the most part in exercises upon the cadaver." Besides, Picque and Dartigues[3] have presented the operative technique in a thoroughly illustrated monograph.

In calling your attention to this subject to-day I had two points in view: First, to decide authoritatively by your discussion the question, not as yet decided by the recorded cases, whether in the treatment of malignant disease of the scapula total extirpation of the bone must be practised in all cases in order to insure a

[1] Philadelphia Medical Journal, vol. vi, p. 26-73.

[2] Zur Geschichte und statistik der totalen Entfermung des Schulterblattes: Verhandlungen der deutschen Gesellschaft f. Chirurgie. Siebenter Congress, 1878, I. p. 137.

[3] Revue de Chirurgie, April, 1900.

permanent cure, or whether by a less heroic procedure equally good results can be obtained?

Do you subscribe to the view of Guermonprez:[1] "From a therapeutic point of view, it is not sufficient to remove the affected portion of bone; the entire bone should be extirpated as if the marrow were affected in its entire extent and the capsule of the neoplasm were formed by the periosteum."

The fear that the disease may extend beyond the area which we can touch and see suggests boldness and thoroughness—the two characteristics of true conservatism.

In the next place, I wished to illustrate the result obtained as to the functions of the arm after total extirpation. The history of the case, for the brief recital of which I ask your indulgence, is the following:

J. T. K., aged thirty-one years, a travelling salesman, single, with no specific history either of the acquired or congenital variety. I saw him first on April 25, 1905. The only trauma to which he might have been subjected could have been produced whilst carrying sample cases. His attention was directed to the enlargement of his shoulder-blade a week before because a vest which he had not worn since last summer did not fit comfortably.

Examination disclosed a tumor the size of a cocoanut extending deep into the axilla without, however, compressing the blood-vessels of that space, for neither was there any other than the physiological difference in the radial pulse of both sides nor was the venous flow obstructed. The motions of the shoulder joint were in nowise interfered with. The lower angle of the scapula projected for a distance of about three inches from the thoracic wall. The tumor was smooth, hard and moved with the scapula but could not be moved without moving the bone. No glands were involved and no other tumor was found anywhere upon the body nor were organic functional disturbances discoverable.

The clinical features of the case made the diagnosis of sarcoma of the scapula practically an easy one. But the treatment presented some perplexing problems, both as to the technique of the

[1] Bulletin Société Anat. Clin. de Lille, 1893, vol. viii. p. 140.

operation and also as to the extent to which surgical interference should be had.

I learned from the patient that several opinions had been expressed declaring the necessity for an interscapulo-thoracic amputation, which, of course, the patient thought of with much fear and the surgeon with much reluctance.

The condition which would make the amputation at the shoulder-joint necessary would depend upon the involvement of the axillary vessels or their sheaths, or possibly the ribs, with which the tumor lay in close contact. If the new growth involved these then clearly the one course open would be amputation; if they were found free, then the excision of the scapula must be considered sufficient.

In order to determine this latter point, namely, the involvement of the structures in the axilla contiguous to the new growth, I made an incision beginning at the anterior margin of the axillary fold, which exposed the tumor and, by traction downward and backward, the axillary space, when to my great relief I found that the tumor could be peeled out of the axilla. (Figs. 1 and 2 illustrate this result.)

The tumor grew from the anterior margin of the body of the scapula and is of the periosteal variety. The function of the joint, so far as performing the ordinary excursions of the shoulder is concerned, is restored to about one-half of what is normal. The closure of the capsular ligament, after separating it from the neck of the scapula, formed, to a limited extent at least, a substitute for an articular socket.

FIG. 1.—Weight of arm separating head of humerus from acromial end of clavicle.

FIG. 2.—Arm supported.

NOTES ON THE SURGERY OF INTRASPINAL TUMORS.

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The surgery of intraspinal tumors is of sufficient interest to justify the recording of a series of cases that have come under my care. A paper read at the last meeting of this Association by Dr. Harte included a statistical review of the published cases of this condition prior to that time. As it is unnecessary at so early a date to again give the statistics I will confine myself to notes on my own experience and comparison of the latter with that of others. My experience is limited to six operations on five patients, one patient having been operated on a second time for recurrence. The first of these cases, operated February 1, 1903, I published in the *Medical and Surgical Reports of the Presbyterian Hospital*, 1904, and in the *Medical News*, October 1, 1904. The others have not been reported. The diagnosis and localization in all of these cases have been made or confirmed by an expert neurologist. It is unessential to the scope of the present paper to describe the symptoms and diagnosis at all minutely, but the following *résumé* may not be without interest.

Unilateral nerve root pain was present and was the first symptom in all but the case of recurrent growth and in Case IV, where there was no nerve root pain and little pain of any kind until late in the course of the disease. The latter first manifested itself by numbness and weakness in the ulnar distribution of the right side.

Numbness is usually the next symptom, but may not appear for some years after the primary nerve root symptoms, *i. e.*, nine years in Case II, five and one-half years in Case V, and two years in Case III. In Case IV numbness with weakness in the dis-

tribution of a single nerve (right ulnar) was the first symptom. This symptom was accompanied or soon followed by the first motor symptom of cord pressure, *i. e.*, weakness or paresis, most often of the lower extremity on the side of the nerve root symptoms, next in frequency the opposite lower extremity and the upper extremity on the same side. The paresis is thus most marked below and advances from below upward.

Girdle sensation, usually with a zone of hyperesthesia above, was present in Cases I, II, III, and IV. The deep reflexes were exaggerated in all cases and in those who could still walk the gait was spastic. Cases II and V were distinctly ataxic. Sensation was diminished or lost over certain areas in all cases except the recurrent case. In Cases I and IV the distribution of the anæsthesia produced a sort of Brown-Sequard palsy. In others the different forms of sensation were unequally affected, thus in Cases II and V the sensation of heat and cold were most affected while tactile sensation was only somewhat blunted. This unequal affection of the different forms of sensation, characteristic of syringomyelia, is not infrequently observed in intraspinal tumors. Sphincteric control was partially, never completely, lost in Cases I, II, IV, and V, and for a short time in Case III. Sweating of the face was very marked in Case I, and of the arms in Case III. Tenderness on pressure over, or on movement of, the spine was present in Cases I, III, IV, and VI, the latter a year after the first operation.

The combination of symptoms in some cases, as in Case IV, are suggestive of syringomyelia.

In all cases the diagnosis and localization of the tumor was confirmed by the operation and in all the cases the tumor was removed. In another case of generalized neurofibromatosis the diagnosis and localization of intraspinal tumor was made and confirmed by autopsy, the patient being first seen in such a septic condition from an enormous bed-sore, exposing the upper half of the femur, that no operation could be undertaken. The lesson of localizing these intraspinal tumors high enough in the spinal canal, as mentioned in the report of my first case, has apparently been well learned.

The location of the tumor in all these cases, except Case V, was in the lower cervical region or cervico-dorsal junction extending

up under the third cervical lamina in Case III (and VI). Case V was in the lower dorsal region. Harte found only 13 per cent. of tumors reported operated on in the cervical region. As I said in my previous report, in the series of operated cases collected by Starr, Bruns, Putnam and others only one was located in the cervical region, but I then found three recent cases in the literature of the subject. But one of my cases, Case III, repeated by reason of recurrence in Case VI, was extradural. Harte found a little over 41 per cent. of operated cases intradural, a higher percentage than in previous statistics, and I found two years ago among fourteen recently reported cases the intradural far in excess of the extradural. Hahn[1] in 1902 reported the ratio of intradural to extradural growths to be two to one. The diagnosis as to the extradural or intradural situation was usually but not always correctly made by the neurologist. Case I was thought to be extradural but proved to be intradural. Case III was correctly diagnosed extradural. Case IV was for a time thought to be intramedullary but subsequently on the basis of the diagnosis of Cases I, II, and III it was correctly diagnosed as an extramedullary and intradural growth and an operation was advised. Cases II and V were correctly diagnosed intradural. In this connection Harte states that "in no case reported (today) was it possible to tell before operation the relation of the growth to the dura, much less the fact whether it was in the substance of the cord or not." The latter differentiation was, however, made in each of my cases correctly. In two cases, IV and V, the growth was posterior and median in situation; in three others, II, III, and VI, it was lateral but more posterior than anterior, and in Case I it was lateral, extending as far anteriorly as posteriorly, and lay anterior to the posterior nerve roots. In three cases, including the recurrence, it was on the left side, in one it was on the right. In Case IV in spite of its posterior situation the symptoms were mainly those of motor paralysis, which led to the diagnosis that it should be situated rather anteriorly.

The nature of the tumor can rarely be diagnosed except where the growths are secondary. 42 per cent. of the cases collected

[1] Hahn. Centralb. f. Chir., 1902, p. 309.

by Harte were sarcomata and of the six tumors I removed the original pathological diagnosis in every case was some form of sarcoma, fibrosarcoma in five cases and round-celled sarcoma in one, the only fatal case. The ground for the diagnosis of a sarcomatous element in most of these fibroma-like tumors is the presence of a more or less considerable number of rather large cells with large nuclei. In Case I the tumor was subsequently examined by Dr. James Ewing who pronounced it endothelioma. I have little doubt that he would class some of the other fibrosarcomata under the same relatively non-malignant group of endothelioma. I think this explains some of the peculiar features of intraspinal tumors that I have observed and to which attention has been called by Harte and others. One is inclined to question the pathological diagnosis of sarcoma in these cass, unless they belong to a relatively non-malignant type like endothelioma, on account of the duration of symptoms before operation and the relative freedom from recurrence after operation.

As to the duration of symptoms before operation, in my cases the time varied from one and one-quarter years to ten years, and averaged 5.8 years, excluding the case of recurrence. Harte found the average duration of symptoms to be two years and three months, or in patients with sarcoma two years and nine months. The duration of symptoms of cord pressure before operation varied from three months to three years and averaged about ten months. The one case of round-celled sarcoma had lasted nine years from the initial symptoms and three years from the onset of symptoms of cord pressure. In the first case operated on the tumor, a fibrosarcoma (endothelioma), had only given symptoms for one year and three months, the most rapid growth of any case, but has remained without recurrence for three years and three months. The duration of symptoms in my cases as in others throws little or no light upon the nature of the tumor.

To explain these conditions we may assume (1) that sarcomatous metamorphosis was a late phase in the growth of the tumors or (2) that sarcomata or certain forms of it in the central nervous system are less malignant than elsewhere, or (3) that the pathological diagnosis is wrong. Sarcomata are somewhat more frequent in extradural than in intradural tumors, a fact that has

been assumed to explain the higher death-rate in the former, in spite of the added danger of infection and meningitis in the latter. In the only case of extradural tumor in my cases the pathological diagnosis was fibrosarcoma and recurrence occurred in ten months as we might expect it in a sarcoma elsewhere. This is the only case in the series where early recurrence occurred, though Case VI is still of too recent date to rule out this possibility.

A history of trauma was obtained in three cases (I, IV, and V). In Case I although the injury did not involve the spine or back the first symptoms appeared not long afterward.

Harte found the mortality of the operation itself to be 28 per cent. and that nearly 47 per cent. died of the operation or its sequelæ. Krause gave the mortality 43.7 per cent., and in the last twelve cases 25 per cent. The higher the tumor the worse the prognosis is said to be, but statistics are insufficient to determine how true this holds. The prognosis should be better now than it would appear to be from Harte's figures, where both recent and old cases are combined.

There was one death in my six operations, a mortality of 16.6 per cent. The fatal case was one of round-celled sarcoma extending the length of five laminæ at the cervico-dorsal junction. It was very difficult to remove it from the flattened cord without injury and the operation was a long one. If we had completed the operation in two stages, as we were compelled to do in Case III with success, the result might possibly have been different. Yet the patient did not die of collapse or shock. She lived seventy hours and was oppressed for breath, though there was no real dyspnœa nor any cyanosis until the last, and there was no sign of phrenic paralysis.

The technique includes first a laminectomy, which is essentially the same whatever the condition for which we operate. Personally, I do not favor the osteoplastic method. It is more complicated, and there is little or no object for its performance as the laminæ and spines add little if anything to the strength of the spine and bear none of the weight. As I stated in my former papers, Sonnenberg attributed the death of a patient from meningitis to the use of Urban's method and the presence of the retained bones If any osteoplastic method is employed I should favor the method

described by Bickham rather than that of Abbe, but I do not know of its having been employed on the living subject and its use would be somewhat experimental. The simplest technique is the best.

After clearing the spines and laminæ, in which process the hemorrhage is not always free and always readily controlled by packing, wet with hot saline, on one side while the other is being worked upon, the spines may be removed with cutting forceps, the laminæ with a flattened rongeur. For the latter purpose some prefer a cutting forceps, Schede or Gigli saw, Bickham or Doyen hand-saw (applied at right angles to the roots of the laminæ next to the pedicles). The hardest part is taking out the first lamina where they are imbricated. When the first one is removed the others follow readily. The laminæ of at least three vertebræ should be removed to give room for the operation within the canal and to allow for the possible uncertainty in localization. For the latter purpose it may be preferable to open the dura after removal of two laminæ to see whether the laminæ above or below require removal. The dura should pulsate if the intradural conditions are normal. A thick sound may be used to explore the extradural part of the canal.

On opening the dura the flow of cerebrospinal fluid may for a moment interfere with the operation. In my first case I found this was readily controlled by lightly packing the subdural space at the upper end of the wound with gauze. I have not found this necessary in the subsequent cases, and from my experience I should say that the proposal of Sick, employed by Schede, to apply a circular extradural constriction for the same purpose is unnecessary and unwise. One sometimes finds localized collections of fluid shut in within a thin membrane of arachnoid in the vicinity of a tumor (Case IV), or more commonly I have found a cyst about the tumor, on opening which the tumor was fully exposed (Cases II and V).

On opening the dura it is not always easy to make out the presence or the position of the tumor. Case V was perfectly plain and near the posterior median line. Case I was lateral, extending anteriorly and was not freely exposed until two posterior nerve roots had been divided. In Case II the exact position

and limits, and even the presence of a tumor, were at first difficult to determine. In this, as in Case IV (and to a less extent Case V), the arachnoid was thickened over the tumor in a lamellated manner so as to require the division of many thin layers before laying bare the tumor, surrounded in part by a cyst whose walls are formed by these layers of arachnoid. If the surface of the cord does not appear normal, but obscured or prominent, the thickened arachnoid must be divided over it until the tumor or cyst or both are exposed. Long-continued pressure flattens the cord in a boat-shaped manner and the central part of the tumor bulges into the center of the cord. Blunt dissection by the finger and small curved elevators is usually sufficient in enucleating the tumor.

I have always sutured the dura with fine catgut, in only one case (Case V) leaving a small drain through it on account of slight oozing. In all cases, however, except Case I and Cases III and VI (extradural), there has been leakage of cerebrospinal fluid along the drain left at the lower angle of the wound down to the dura. This may perhaps be due to slight leakage around the suture punctures, if a Hagedorn needle is used, so that it is wise to use a round needle to avoid it. In Case II this discharge was readily controlled by the pressure of a longitudinal pad along the course of the wound. I have noticed no difference in the after-course of the case between cases where there is leakage of fluid and those where there is none, though in the former one has more to dread from the possibilities of infection. The muscles are approximated by interrupted sutures and the fascia firmly sutured with chromic gut.

In two cases, Cases II and V, the wound broke open superficially after apparent union and the removal of the sutures. Whether this was due to delayed union, on account of the constant watery discharge, to trophic disturbances or to strain on the wound owing to the pressure of the weight of the body in case of restlessness (in Case V, at least, it was due to the latter cause), I am of opinion that these wounds should be sutured with some material like silkworm-gut so that the sutures or some of them may be left in longer than the usual time. This was done in Case VI. In none of the cases that opened was the separation more than superficial, down to the deep (cervical or vertebral) fascia.

Further opening of the wound was prevented by the suture of the deep fascia with chromic gut.

An important lesson that was taught me by Cases III and IV, and one the importance of which deserves emphasis, was the wisdom of performing the operation in two stages. This was made compulsory in Case III on account of the failure of the pulse and respiration. The patient responded to stimulation, including artificial respiration and infusion, and was in much better condition at the time of the second operation two days later. This case was an extradural one, but the same course should be followed in the intradural ones. I think Case IV should have been so operated. Unless the condition of the patient actually forbids I would advise opening the dura at the first stage. This adds little to the time consumed or to the shock of the operation. In this way the presence or position of the tumor may be learned and one can tell whether or what additional laminæ require removal at the second operation. The dura may then be temporarily sutured to prevent the excessive flow of cerebrospinal fluid. The blood pressure as determined by the sphygmomanometer may indicate whether the operation should be suspended and completed at a subsequent date. I do not think it necessary to advise this plan in all cases as Horsley has done in the case of brain tumors.

The postoperative course has varied with the particular case, but in general, immediately after the operation and for some days, there has been a marked increase of the paralysis, often of parts not previously paralyzed. This increase of paralysis begins to decrease soon, the second day in Case III, not for two weeks in Cases I and II. The improvement in the power of motion may be rapid as in Case III (extradural), in which it was nearly complete in a few weeks, or more slow as in all the other cases, the parts most affected being the last and the slowest to improve. There was paresthesia (Case I) or pain in the extremities in the other cases, which was increased or brought on by motion. This may be very troublesome, but after reaching its height in a few days it diminishes and is usually gone by the end of two or three weeks. Sensation is usually but little affected by the operation. The bladder and rectum may be temporarily more or less incontinent. The subsequent improvement in symptoms, especially

in motor power, is usually slow and gradual but may continue for a long time, especially when the pressure has lasted a long time. In Case I reported by Warren[1] improvement was noted five and six years after the operation. In my third case functional recovery was good at the end of two weeks except for the finer movements in the left hand and some muscular weakness. After the operation for recurrence this patient made a much slower functional recovery. None of the cases, save the fatal case dying after seventy hours, failed to show marked, to nearly complete, functional recovery.

I add a few of the features of especial interest in some of the six cases, in addition to the histories.

Case II showed the importance of an air bed from the very first after the operation. There was a delay of only twenty hours in getting this patient on such a bed with the result that a pressure sore developed over the sacrum and each heel. This case, like Case V, showed the tendency to the superficial opening of the wound after apparent perfect union and the removal of the sutures on the eighth (or seventh) day. This emphasizes the importance of using some sutures of silkworm gut, which can be left in longer than silk, and of the firm suture of the deep fascia with chromic gut. The length of time of the invasion (ten years) was unusually long in this case. Case II also developed a peripheral peroneal palsy, from pressure or stretching while on the operating table in a modified Sims' position, or subsequently, in bed, when there was for the time paralysis of the lower extremities. The peroneal palsy was completely recovered from.

The interesting features of Case III were (1) the height to which it extended, requiring removal of most of the third cervical laminæ, although there were no symptoms of disturbance of the phrenic nerve. (2) The compulsory and successful performance of the operation in two stages. At the second operation, two days later, the patient was in far better condition, owing to the infusion and the stimulating and nutritive enemata, and she stood the operation well. (3) The rapid functional recovery. On the second day she began to move the left or most paralyzed hand and arm and by the fourteenth day she could perform slowly all but the finer movements. Motion and sensation were elsewhere normal.

[1] Transactions of American Surgical Association, 1905, p. 129.

On the thirteenth day after operation she could walk and maintain her equilibrium with closed eyes. (4) The pathological diagnosis was fibrosarcoma but the microscopic appearance was different from the other cases called fibrosarcoma, while its malignancy was shown by a recurrence which began to give symptoms ten months after the first operation. In the removal of the recurrence (Case VI) the tumor was as before encapsulated in part at least, though it appeared to extend out into or through one or more intervertebral foramina. The functional recovery especially of the left upper extremity was far slower than before. Three months after the operation it was still very weak. Further recurrence is of course to be expected. The bony opening into the spinal canal in this case had closed but little, if at all, in the course of a year.

Case IV. The tumor here extended the length of six laminæ and had compressed and flattened the cord very markedly. The length of time required for its removal should have been divided into two operations with an interval of two or more days. Possibly in this way the fatal result at the end of seventy hours would not have occurred, though the nature of the tumor, small round-celled sarcoma, would indicate a probable recurrence. In spite of the posterior situation of the tumor there was no nerve root pain, only numbness and weakness leading to the diagnosis of a tumor situated anteriorly. For a time it was thought that this was an intramedullary growth. The patient called for air on recovery from anesthesia and continued to do so. At first there was no real dyspnœa or cyanosis and respiration was normal; later the breathing was labored and cyanosis developed near the end. There was no evidence of paralysis of the phrenic nerve.

Case V. Here, as in Case II, the wound opened superficially, during a period of restlessness, nine days after operation, after apparent union and the removal of the sutures. There was also a free discharge of cerebrospinal fluid. Ten days after operation the neck was retracted and stiff, the pulse and temperature rose, there developed a marked tremor and he was apathetic and irrational. Fearing a spinal meningitis, a lumbar puncture was made eighteen days after operation and withdrew very slightly turbid fluid, showing non-pathogenic bacilli and cocci. After

the puncture the patient was quieter and better in every way. Four days later, the symptoms recurring, lumbar puncture was again employed with relief of symptoms. The culture showed saprophytes. A third puncture was made a month later and the fluid was entirely normal. The combination of a suppurating surface wound, a discharge of cerebrospinal fluid and the symptoms of spinal irritation led to the fear of meningitis, though there was probably little more than irritation. He eventually made a good recovery.

The tendency to the opening up of the incision unless silkworm gut sutures are left in, and the advisability of operating in two stages in severe cases, are two of the lessons taught by the above cases.

Case I.[1]—Mrs. S., aged thirty-four years, referred to me by Dr. Joseph Fraenkel, who diagnosed and localized the tumor, entered the Presbyterian Hospital February 1, 1903. Seventeen months before she bruised the left hip in a fall. Fifteen months before felt pain in left shoulder, later extending to other shoulder and back of neck and then to the chest. Three months before noticed weakness of left upper extremity, soon after of left lower extremity. At the same time a girdle sensation was felt about the upper abdomen. Later, sensation on the right side was impaired. Sphincters insufficient for past month. On examination tingling in the hands, more marked in the left, diminished sensation in left ulnar distribution, disturbance of temperature sense on both sides of trunk, exaggeration of the deep reflexes, sweating of the face, tenderness over fourth thoracic vertebra on left lateral pressure, were noted. Tumor localized at sixth cervical segment. Operation February 2, 1903. Ether anesthesia. Spines and laminæ of fourth to seventh (inclusive) cervical vertebræ removed. Dura incised. Gauze inserted between dura and cord to check flow of fluid. Nothing seen at first. Opposite sixth lamina some bulging of cord and resistance to probe on the left where, pressing cord to right, bluish prominence seen anterior to posterior nerve roots, two of which were divided to expose it. After dividing capsule, apparently continuous with pia, between cord and tumor,

[1] Reported more fully in Medical News, Oct. 1, 1904.

the latter readily shelled out by blunt dissection. Suture of dura, muscles and skin. A cigarette drain was inserted down to the dura. Healing per primam. After operation paralysis increased, especially on left side. No improvement for nearly two weeks. Since then steady improvement for a year or two. Three years after operation the condition is practically normal except that the left upper extremity is slightly paretic and ataxic. The tumor was an endothelioma.

Case II.—W. M., aged forty-five years, single. Admitted to the Presbyterian Hospital, September 6, 1904. Referred to me by Dr. J. Ramsay Hunt, who made the diagnosis and localized the tumor. Family, personal, and general history negative. Present trouble began about ten years ago with pain in right chest at level of nipple, soon shooting through middle of right upper extremity, and five years later through left upper extremity. Cord pressure symptoms began one year ago with numbness and weakness of right foot, which increased until two months ago; he was unable to walk upstairs. About a year ago girdle sensation about waist. Lately left leg affected and sphincteric control diminished.

Physical Examination. In addition to above symptoms, deep reflexes exaggerated, cutaneous reflexes diminished. Sensation of heat and cold impaired and considerable blunting of all sensation in lower extremities. Some ataxia and spasticity in legs. Pain and numbness along right ulnar distribution. Tumor diagnosed as intradural and localized at eighth cervical segment by Dr. Hunt. Operation September 7, 1904. Gas and ether anæsthesia. Sims' position on left side. Median incision from second thoracic to about fourth cervical spine deepened to spines. Soft parts removed from spines and laminæ of sixth and seventh cervical and first dorsal vertebræ, first on one side then on the other, the bleeding being readily checked by hot compresses on one side while working upon the other. The spines of the sixth and seventh cervical and first thoracic vertebræ were removed with bone-cutting forceps and the corresponding laminæ with flat rongeur. The dura was opened in the median line disclosing, beneath the seventh lamina, a firmer area of a darker color than normal. After dividing many layers of arachnoid and a thin

bridge of what appeared to be nerve tissue a cyst cavity was opened disclosing a tumor on the right posterior aspect extending down beneath the first thoracic lamina. This was removed by blunt dissection and measured 1½ inches long by ½ x ¼ inch broad The dura was closed with fine catgut, the muscles with interrupted catgut, the fascia with continuous chromic catgut and the skin with silk. At the lower angle of the wound a rubber tissue drain was introduced down to the dura and removed two days later. Sutures removed on the eighth day, and not long afterward part of wound opened to fascia. It was strapped together and healed slowly (three and one-half weeks). Free discharge of clear cerebrospinal fluid until pressure with a pad arrested it and it finally ceased after eighteen days. For first twenty hours after operation the patient was not on an air-bed, and in spite of careful nursing a shallow bedsore developed over the sacrum and on each heel during the second week. The power of right leg was completely lost, that of left leg nearly so. Sensation was not impaired, but there was pain and painful twitchings in legs and in arms, and the latter were very weak. This pain lasted between two and three weeks, gradually diminishing. He was irrational and delirious much of the time for first week. Catheterized for first week. The paralysis gradually cleared up and by the end of third week the arms were freely movable, but the legs improved more slowly. A peripheral peroneal paralysis of left leg was noticed, due to pressure or stretching on the operating table or during the early post-operative period. The improvement in lower extremities was slow and steady, the peroneal palsy cleared up and now, twenty months after operation, he walks with two canes and on good days with one cane. Gait weak and spastic in right leg. He has no pain. The microscopic diagnosis of the tumor in the hospital laboratory was "fibrosarcoma, vessels fairly numerous."

Case III.—Mrs. C. C., aged thirty-one years. Admitted to the Presbyterian Hospital October 27, 1904. The patient was referred to me by Dr. Max Mailhouse, of New Haven, Conn., who had diagnosed and localized the tumor. She was also seen in consultation by Dr. C. L. Dana. Family, previous and venereal history negative. The present trouble began in January, 1902 (two and three-quarters years ago) with pain in back of neck and

between shoulders, the head and left shoulder being spasmodically drawn together. Two years later (January, 1904) numbness and tingling followed by weakness of left hand, spreading up the arm. Late in February, 1904, the same numbness and paresthesia in the right hand, and a month later the left leg became weak and paresthetic. Since July, 1904, could not walk without help. Since June, 1904, there has been a girdle sensation about waist which grew broader. For past two months has perspired excessively in upper extremities, especially on the left side. Some trouble in starting urination in August, no incontinence. On examination, besides the symptoms already noted, the neck was found rigid and tender, deep reflexes exaggerated, sensation normal except for strip of anesthesia two inches wide and six inches long to the left of spinal column. Left leg weaker than right and left arm almost devoid of motion and somewhat spastic. Diagnosis: extradural tumor of sixth and seventh cervical segments. Operation, October 29, 1904. Gas and ether anesthesia. Modified Sims' position; on the right side. Technique same as in Case II. Spines and laminæ of fourth, fifth and sixth cervical vertebræ removed. Oval tumor $1\frac{1}{4} \times \frac{1}{2}$ inch exposed on left posterolateral aspect opposite fourth lamina and extending up under third. Tumor encapsulated. Capsule, very adherent to dura, was opened, showing enucleable tumor. Owing to sudden failure of pulse and then of respiration, artificial respiration and an infusion of 1000 c.c. were employed, and the wound temporarily packed and brought together by a few sutures. She reacted well to stimulation. Stimulating and nutritive enemata for the next forty-two hours brought the patient into better condition than before the operation. Hence, October 31st, second operation performed under gas and ether anæsthesia with the patient on the left side. Wound reopened. Part of third cervical lamina removed and tumor removed piecemeal by blunt and sharp dissection, during which oozing of blood was troublesome. Small opening made in dura, where capsule was most adherent, closed by catgut suture. Tumor seemed to spring from dura and not to be attached to other structures. Wound closed as in Case II. The condition of patient remained good throughout. About the second day she began to use the left hand and by the fourteenth, when she left the hospital,

almost all movements except the finer ones were performed slowly. November 4th, noted that motion, except in left upper extremity, was normal. Pain in extremities was severe but was almost gone by the 13th. Wound healed per primam. No leakage of fluid. Microscopic examination, fibrosarcoma. She made a practically complete recovery. See Case VI.

Case IV.—Mrs. R. A., aged forty-six years. Admitted to the Presbyterian Hospital June 12, 1905. She was a patient of Dr. I. Abrahamson and was referred to me by Dr. C. L. Dana. One brother died of brain tumor, thought to be due to trauma. History of a fall, striking on vertebra prominens, followed by pain for a day or so. Nine years ago, just before a vaginal operation, noticed numbness and weakness in ulnar distribution of right hand and forearm. Three years ago right leg became weak and ataxic. Two years ago both knees, especially right, became stiff and contracted, making walking impossible since nine months ago. For six months has had no control of urine and, for the past month, of flatus. For three months there has been pain in right submammary region and recently a girdle sensation. There is general anesthesia of the left leg and trunk up to about the fifth rib, of the right side of trunk from the third rib to the groin, and of the ulnar distribution of the right arm. Tumor localized at eighth cervical and first and second thoracic segments. Operation June 14, 1905. Gas and ether anesthesia. Modified Sims' position on left side. Technique as in Case II. Fifth, sixth, seventh cervical and, later, first dorsal spines and laminæ removed. Dura tense and without pulsation. On opening it a small amount of clear fluid escaped as if under considerable pressure. Fluid came from cyst in relation to tumor, which was elongated and lobulated and lay on the posterior surface of the cord, flattening it. It extended from the upper margin of fourth cervical to the lower margin of the second thoracic vertebra. Tumor carefully dissected off by blunt and sharp dissection. Operation lasted over two hours, owing to difficulty of removal. Wound closed as in Case II. During operation respiration became more feeble and irregular and finally ceased but was quickly resumed. Infusion of 1250 c.c. 0.09 salt solution with adrenalin m. x. on table. On recovery from anesthesia kept calling for air. No cyanosis or

dyspnœa. June 16th. Breathing more labored and on the following day before death there was cyanosis. Pain all over the body, patient nervous and restless and at times irrational. Dressed on 17th and a considerable amount of cerebrospinal fluid escaped on removal of drain. Pulse and respiration failed in spite of stimulation and patient died seventy hours after operation. Microscopic examination: Tumor a round-celled sarcoma.

Case V.—J. S., aged fifty-nine years. Admitted to the Presbyterian Hospital August 14, 1905. Family, personal and venereal history negative. About six years ago, three months after a fall in which he injured the back below the left scapula, he developed pain in left lumbar region two inches above iliac crest. This continued until seven or eight months ago. Seven months ago noticed numbness on inner side of each big toe, which slowly extended so as to involve ankles, legs and thighs, until now stationary just below umbilicus, *i. e.*, up to nerve root zone. Next, he noticed ataxia and weakness of gait and later some loss of control over bladder. Now complains of burning pain from soles of feet to waist line. Ataxia and weakness became worse, continued support in walking was necessary and lately he can scarcely walk. On examination, in addition to above symptoms, deep reflexes exaggerated, especially on the left. All sensations diminished below level of umbilicus, more decidedly in lower part of leg. Sensations unequally affected, heat and cold more than tactile sensation. Tumor diagnosed as intradural and localized at tenth dorsal segment by Dr. J. Ramsay Hunt. Operation August 28, 1905. Gas and ether. Sims' position on left side. Technique as in Case II. Spines and laminæ of eighth, ninth and tenth thoracic vertebræ removed. Tumor exposed beneath ninth laminæ, surrounded by clear, encysted fluid. Tumor $\frac{3}{4}$ x $\frac{1}{2}$ inch, situated posteriorly but somewhat more to left, shelled out easily after ligating and dividing small vascular pedicle at either end. Wound closed as in Case II save for a drain of three strands of catgut through dura on account of slight oozing.

Postoperative History. Some pain in wound and above. September 2d, drain removed. Some watery discharge. September 4th, sutures removed, wound healed, but two days later opened down to fascia and watery discharge profuse. September 7th,

neck retracted and stiff, temperature has risen again after reaching normal. September 9th, marked tremor and muscular twitching. Patient apathetic or restless and irrational. September 15th, lumbar puncture withdrew one ounce of slightly turbid fluid containing non-pathogenic bacilli and cocci, and was followed by temporary improvement. Lumbar puncture repeated on September 19th with same result. October 2d, temperature remittent and when low patient quiet and nearly rational, when high apathetic and tremor marked. Neck still stiff. October 22d. Lumbar puncture, fluid normal. Temperature normal and hereafter continued so. November 9th, sat up in chair. November 16th, walked about fifty feet. Sensation normal except for loss of muscle sense. Reflexes more or less exaggerated. Tumor, fibrosarcoma. Seen in March, 1906. He walked with one cane, practically no ataxia. Sensation in the lower extremities practically normal. Ankle clonus was still present on the left. Further improvement to be expected.

Case VI.—Mrs. C. C., aged thirty-two years. Admitted to the Presbyterian Hospital October 20, 1905. See Case III. Since discharge from hospital, November 13, 1904, she continued to improve and in a short time was practically well and continued so until eight weeks ago when she began to notice that she was weaker in hands and arms and soon after complained of numbness which does not extend above the hands. For past two or three weeks the legs have been growing weaker. On examination the deep reflexes are exaggerated. Movement of neck restricted. A point of tenderness about one and one-half inches above vertebra prominens. October 26, 1905, operation. Gas and ether anesthesia. Incision to one side of old scar. Part of laminæ of seventh cervical vertebra removed to determine level of dura, which was covered by scar tissue above. The latter was readily separated from the dura. Cord seemed flattened on left side and after careful dissection a tumor 2 x $\frac{3}{4}$ inches was exposed on left lateral aspect of cord. This was encapsulated, at least in part. Tumor was removed piecemeal. Capsule on side toward dura removed, the latter being torn with escape of considerable cerebrospinal fluid. The opening was sutured. Tumor filled left half of canal extending out into two or more intervertebral foraminæ. Two

or three nerve roots exposed by the blunt removal apparently uninvolved. Tumor extended no higher than before but somewhat lower. Wound closed as before except for a number of interrupted silkworm gut sutures. Some postoperative shock but stimulation responded to.

Postoperative Notes. Considerable paralysis of both upper and lower extremities after operation. Soon began to move right leg, then right arm, then left leg, but recovery much slower than after first operation. November 12th, both lower extremities are moved well. Right arm weak but moved freely. Only slight motion in left arm which is steadily but slowly improving. Considerable pain was complained of in legs and some in neck. Sat up November 10th and went home November 12th. Microscopic examination, fibrosarcoma. February 3, 1906, recovery has been very slow but more noticeable the past two weeks. Left side still very weak. She can walk with some assistance. The use of left hand not yet regained. May 23d,[1] gait has improved so that she walks very well and can even stand on left foot without any other support. There is still ankle clonus and exaggerated knee jerks on both sides. The left arm remains spastic and paretic with flexion of fingers; and she can do little with the hand. No evidence of recurrence as yet.

[1] Personal communication from Dr. Mailhouse

ON THE PRESENT STATUS OF OUR KNOWLEDGE OF SEROTHERAPY IN SURGICAL AFFECTIONS.

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This communication represents an unsatisfactory attempt to fill the indication which the title expresses—unsatisfactory, because the subject is a difficult one to consider in a conclusive way. Much has been written on it, but the greater part of that which has been written is hardly to be classed as authoritative. It consists in large part of scattered cases incompletely analyzed —cases which are worthless from the standpoint of scientific demonstration.

In considering the subject broadly a distinction should first be made between the toxæmiæ and the bacteriæmiæ. The former embrace tetanus, diphtheria, pyocyaneus disease and botulismus (meat-poisoning). The bacteriemiæ, such as streptococcus, staphylococcus, pneumococcus and gonococcus, represent more than a toxæmia in that the pathogenic bacteria gain access to the blood and the resulting pathological condition is a bacteriotoxæmia. Therefore, the serum which is indicated in these conditions should be more than a mere soluble chemical antidote, it should possess bacteriocidal properties.

It is not necessary in this place to carry research to the original inception of the subject for that has been done in numerous recent articles. One of the latest and most authentic of these is by Professor Vaughn (*Physician and Surgeon*, May, 1904), who is particularly well qualified to deal with the subject and who appears to have covered most of the general and special reports on antistreptococcus serotherapy. We may accept his conclusions as warranted by an analysis of the data and by the consensus

of expert opinion. He decides that we do not as yet know enough about the streptococcus toxin, and that until we can produce a soluble antitoxin we can expect nothing of practical value. The various sera on the market are prepared with the best intentions but possess no therapeutic efficacy. Vaughn's paper further makes it apparent that the literature of the serotherapy of purely surgical affections is meagre in comparison with the medical, pediatrical and obstetrical contributions. He makes but little allusion to sera other than the streptococcic varieties, with the exception of tetanus antitoxin. He cites Doyen's experience with antistaphylococcic serum, published in 1903, but the favorable results alleged to have occurred from its therapeutic use appear to have received no corroboration at the time. Further, the conditions said to have been cured were in the main such minor ailments as boils, abscesses, carbuncles and the like. Vaughn's valuable paper deals extensively with the principles which underlie the preparation of the various antistreptococcic sera and the technique of their manufacture. As it can readily be consulted in the original it is not necessary to quote from it at length.

In briefly noting some of the literature of surgical sera for the period which has elapsed since Vaughn's report the writer will endeavor to be guided by the following principles:

1. Isolated reports of one or a few cases will be omitted. Most reports of this character emanate from physicians who, being perhaps unfamiliar with surgical diagnosis and operative management, choose to make use of a serum when medical measures fail and do not give their patients the benefit of ordinary surgical procedures.

2. As far as possible dependence will be made on the testimony of surgeons, embodied in systematic writings on septic affections, where, under the head of treatment, serotherapy is compared with other measures and a reasonable verdict thereby rendered.

3. Scientific requirements should be fulfilled as far as possible. It should be shown in individual cases that a correct diagnosis has been made and that the infection is a pure one. Further, the mere fact that a patient recovers is not sufficient for a demonstration. Further, given the special symptoms produced by a certain germ, it should be shown that the serum shortly after its

administration favorably modified these symptoms so far as the latter could have been due to the specific toxæmia or bacteriotoxemia of the disease.

These conditions are rigorous, but only upon such can the validity of surgical serotherapy be established. If its validity could be established the practitioner would be justified in using it as an adjunct procedure in surgical affections; but until the principle can be shown to be sound, recoveries apparently due to the use of sera should not be reported, for such data are misleading. They establish false hopes and in a measure prevent practitioners from resorting to ordinary surgical measures.

Under the conditions above imposed the reports on the serotherapy of septicæmia worthy of credence which have appeared since Vaughn's paper are very few in number, and even where negative reports might be expected modern authors are generally silent. Fowler, in his recent work on surgery, ignores the subject. The same may be said of Gould's *Year-Book of Surgery* for 1905. Murphy, of Chicago, in his volume of *Clinical Surgery* in the Year-Book Series for 1905, contents himself with quoting Vaughn's conclusions. During the past two years the *Centralblatt f. Chirurgie* cites next to nothing on the serotherapy of septic conditions. An elaborate paper on the treatment of diffuse suppurative peritonitis, rich in cases from von Eiselsberg's clinic in Vienna, makes no mention of serotherapy (Clairmont and Ranzi, *Arch. f. klin. Chirurgie*, 1905, lxxvi, p. 68). Tavel, in his excellent monograph "Chirurgische Infektionen und deren Prophylaxe" (Berlin, 1905) makes hardly any allusion to serotherapy or seroprophylaxis and expresses no definite opinion. He cites with apparent approval Metchnikoff's belief that sera can do no more than stimulate a bactericidal phagocytosis, but gives other and simpler measures for carrying out this indication. Otogenic septicæmia would seem a fruitful field for the testing of sera, yet Randall (*Journal of the American Medical Association*, 1906, xliii), in an exhaustive paper on the treatment of this affection, does not allude to it. In the latest edition of Finger's work on gonorrhœa there is no allusion to serotherapy or seroprophylaxis. On the other hand, Rose and Carless, in the latest edition of their *Manual of Surgery*, 1905, make frequent allusion to the use of antistrep-

tococcic serum in purulent cellulitis, septicæmia, pyæmia and erysipelas, referring as well to its use for prophylactic purposes in those operations which are prone to be followed by sepsis. The arguments given may be condensed to the single statement that certain cases appear to show benefit after the use of sera—a contention without sustaining force. They urge correct diagnosis and early employment of a polyvalent serum. Their teachings are far from convincing to one who has studied the subject. No personal experience is given, no definite reasoning from statistical material. Their statements appear based on a natural desire to give any new measure which has a reasonably scientific foundation a fair chance, and a further desire to enumerate under therapeutic resources any measure which has partisans.

Rose and Carless appear to show more enthusiasm for the alleged curative properties of antistreptococcus serum in erysipelas than in other application of serotherapy, yet this idea seems to have been thoroughly exploded by others: Thus, Lauber, in his monograph on the treatment of erysipelas in 1898, shows that the chief argument for the serotherapy of this disease rests upon the results of Chantemesse with Marmorek's serum in a series of several hundred cases controlled by a correspondingly large number treated without serum. But the margin in favor of serum treatment is exceedingly small and even this seems negatived by the work of Koch and Petruschky, 1897, with experimental erysipelas. These authors showed that antistreptococcic serum could neither prevent the appearance of the disease nor modify its course when developed. Quite recently Rona (*Ungar. Med. Presse*, 1905, x, 335), a credible authority, announced that he had treated 5000 cases of erysipelas since 1899 and that no form of serum treatment had the slightest influence on the disease. Lenhartz, in his monograph on "Erysipelas" (*Nothnagel's Handb. sp. Pathol. u. Ther.*, 1903), arrives at similar conclusions. Italian authors have during the past few years reported successes in the treatment of malignant pustule with antianthrax sera, but these reports seem to the writer to carry no more weight than any isolated instances of alleged recovery from the use of a new remedy. They may be placed in the same class with a great number of alleged positive results in the serotherapy of puerperal fever,

scarlatina, erysipelas and the like, all of which fail to answer the demands of a rigorous scientific investigation. It is far from enough to say that a given case recovers after the use of a serum.

When we seek authors competent to speak and who have insisted upon adherence to strict methods of analysis we find few who reach the standard. It is much easier to ignore or condemn or speak equivocally and temporizingly than to meet the subject fairly from all points of view. Most of the general papers in which the pros and cons are weighed come from the laboratory. One of the few surgeons competent to discuss the subject in all its phases and who has definitely taken a position on it is Lenhartz, who, in view of his great monograph *Die septische Erkrankungen*, 1903, may be regarded as an eminent authority on the therapeutics of surgical sepsis. His labors are based on the clinic at Hamburg-Eppendorf Hospital, and he plainly states that there is not the slightest doubt as to the inefficacy of Marmorek's and the other antistreptococcic sera. This statement is sustained by the crucial experiments of Petruschky on erysipelas. The serum exerted no influence whatever on the course of this disease and was unable to prevent it. Lenhartz studied a great number of cases of sepsis in which an absolute diagnosis of pure streptococcus infection was made. He cites several examples in which streptococci were found in the blood to the exclusion of other germs. These cases with positive blood findings are peculiarly adapted for serum treatment. Neither in the fatal nor other cases was there the slightest modification of the typical streptococcus temperature curve. The cases pursued their regular course. Lenhartz says that in some septic cases the serum treatment causes untoward collateral phenomena.

From a study of the very careful work of Lenhartz one can but gather the thought that while he believes that the principle of serotherapy may be sound in theory it is at present impracticable of execution. Vaughn cites several authors who believe that when serotherapy is apparently effective it does not represent a chemical antidote to toxins or even a bactericidal or bacteriolytic action but merely a stimulation of defensive phagocytosis. Raymond Petie, upon this theory, used warm horse serum as a stimulant of leukocytosis. Jayle, in France (*Presse medicale*, 1905, 722),

and Federmann, in Germany (representing Professor Sonnenberg, *Ctbl. f. Chirurgie*, 1905, p. 358), have injected this serum under the skin of the thigh in severe septic conditions in which the blood count showed a great diminution of leukocytosis. The material is small and no great claim is made for the treatment, but judging from the prognostic outlook the favorable results could hardly be attributed to coincidence. It may be added that horse serum is notably weakened by attempts at preservation. In the same connection may be mentioned a series of cases reported by Hoffer von Sulenthal (*Fortschritt. d. Med.*, 1904), in which human convalescent serum was used for erysipelas. This seems to show that serum quickly deteriorates in activity despite the use of preservatives. These conclusions appear to indicate that the preparation of permanent marketable sera is attended by great drawbacks. Believers in specific antidotes for septicæmia claim that if we cannot apply the special antitoxic or bacteriolytic serum, because of difficulties in diagnosis, these difficulties may be met by the use of polyvalent sera; but those who see in serotherapy only a stimulation of Nature's powers of bacteriocidal phagocytosis do not seek a specific serum but rather the best means of filling this indication. Sera therefore enter into immediate competition with other methods of attaining this result.

Other authorities may be adduced at length, but to the same general effect. My own opinion coincides with the foregoing. I have seen the sera extensively used in various forms of septicæmia but without favorable results which could be justly attributed to the measure. I venture the thought that the general practitioner should definitely understand that streptococcic and similar infections should be managed on the older, established surgical principles.

Tetanus, however, seems worthy of being placed in a separate class. It will be accorded but hasty consideration here for it is the subject of special reports by others in attendance on this meeting. My own view is that, while the antitetanic serum fails in severe and advanced cases, it is of definite value as a prophylactic and in mild and recent cases. An excellent recent article on the subject is that of Suter, "Zur Serumbehandlung des Starr-Krampfes," etc. (*Arch. f. klin. Chirurgie*, 1905, lxxv, 113), who concerns

himself especially with cases which develop despite prophylactic injections. Of fourteen ordinary cases in which the serum was injected in all possible ways but two survived. One of these was treated by intraspinal and the other by subcutaneous injections. The cases were all of a severe type.

The number of cases of tetanusdeveloping despite prophylactic injections is yet too small for judgment, even if we include all published material. In certain instances the condition which develops is mild in character—quite a number of these are on record. Many fatal cases are known to occur despite both prophylactic and so-called curative injections. In most instances the ordinary antispasmodics are employed as well as the serum, and it is difficult to accord to each measure its true value. The whole subject is at present hazy, but it will become clear as competent observers publish detailed accounts of definitely authenticated cases.

PULSATING EXOPHTHALMOS.

LIGATURE OF THE COMMON CAROTID, EXTERNAL CAROTID, AND SUPERIOR THYROID ARTERIES.

By JOSEPH RANSOHOFF, M.D., F.R.C.S.,
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There are few surgical conditions in which the clinical diagnosis is so self-evident as in pulsating exophthalmos. Considered from the viewpoint of its etiology, the pulsating bulbar protrusion is only one, if even the chief, of the end-results of diverse pathological beginnings. Since the disease has rarely been allowed to proceed to its natural termination, sloughing of the eyeball and eventually death from infection or from hemorrhage, the opportunities for autopsy study of the underlying conditions have been relatively few.

According to Harlan,[1] in eighteen postmortems there were found one post-orbital aneurysm of the ophthalmic artery, one aneurysm of the carotid artery in the cavernous sinus, four dilatations of the artery in the sinus, three wounds of the artery in the sinus, five thromboses of the cavernous sinus and ophthalmic vein, two dilatations of the sinus and ophthalmic vein, one pressure on the sinus by growth from without, and one of both ophthalmic arteries (doubtful).

According to Wilder,[2] in twenty-four autopsies made up to 1890, there was a traumatic or spontaneous rupture of the internal carotid within the sinus in seven; in four there was an aneurysmal dilatation of the artery without rupture; in six clinically characteristic cases no lesion of the carotid was found; in one there was an intracranial aneurysm of the ophthalmic; in four cases, vascular retrobulbar tumors were found, and in two of these the growths

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Del. ad Nat.

came from within the skull cavity. While it is hardly in accord with scientific nomenclature to designate a disease by any one symptom, no matter how prominent, it is evident that until the methods of determining the underlying pathological conditions are improved there is every reason for retaining the term "pulsating exophthalmos." There is assuredly reason enough for cutting short the tendency to substitute the term "arteriovenous aneurysm," since in nearly 50 per cent. of the autopsy reports such a condition was not found.

The clear history of trauma, or of some violent effort and sudden onset of symptoms, is valuable in establishing the aneurysmal nature of the individual case. Such a history has been elucidated in about 60 per cent. of all cases. Paralysis of the abducens, supervening early from the very nature of things, speaks in favor of aneurysmal disease and rupture.

In very exceptional cases the exophthalmos has been bilateral, a condition to account for which an injury of both carotids has been assumed to exist. As a rule, in these cases the disease extends from one orbit to the other after a long interval. The circular sinus of Ridley connecting the two cavernous sinuses easily accounts for the extension of the venous dilatation from side to side. Furthermore, I know of no case in which the autopsy report showed involvement of both carotid arteries.

The literature of the subject amply shows that a spontaneous cure through the organization of a thrombus is possible. At least ten cases of complete cure had been recorded up to 1890. Wilder has had one case under observation for thirteen years, the patient doing the hard work of a switchman.

The surgical treatment of pulsating exophthalmos has been practically reduced to the measure of tying the common carotid artery, to the exclusion of every other procedure, although within the past two decades improvements and even cures have been reported from digital compression by Despaquet,[3] Walker,[4] and Kipp.[5] In most of the cases, however, compression failed of results. As a last resort, or as supplementary to tying the carotid, an excision of as much as possible of the varicose vessels has been practised in a comparatively small number of cases.

In 1899, Bodon[6] collected 58 traumatic cases in which the

carotid of one side had been tied. Of this number, 26, or 46 per cent., were cured; 20, or 35 per cent., improved; unimproved, 6, or 10 per cent.; and died, 6, or 10 per cent.

From the literature of the last seven years I have been enabled to collect reports of 21 cases, including my own, in which the common carotid was tied. Of these, 14 were reported as cures. In 5, the cures were partial, or there was a recurrence. In only 1 case death followed the operation.[7] The case of Barna and Rugby[8] ended fatally, from cerebral abscess following a bullet wound. In addition to the 6 cases quoted by Bodon, in which both carotids were tied for exophthalmos, and all of which recovered, two others have been reported, one by Lilienthal,[9] which was followed by failure, and one by Hansel,[10] in which death followed from convulsion.

The comparative harmlessness of tying the common carotid has been amply established. The danger of secondary hemorrhage from the wound has been practically eliminated, as has that from sepsis. The only factor with which we cannot deal is the unilateral cerebral ischæmia. I have had the misfortune to lose a patient from coma and hemiplegia, in whom a prophylactic ligation of the external carotid was attempted preliminary to the removal of an enormous tumor of the jaw. The patient never regained consciousness. The autopsy revealed a high division of the carotid, the superior thyroid springing from the common carotid, and the ligature tied about the latter above the origin of the thyroid. Seaman[11] reports a hemiplegia which continued for years.

The failures, partial cures, and recurrences which have followed tying the carotid alone have resulted from too rapid return of the anastomotic circulation. For at least seventy years (Blackman)[12] the importance of the inferior and superior thyroid arteries in hastening the back flow by means of the external carotid into the internal has been recognized. For this reason, in the case to be reported, I followed the plan of Legouest,[13] of tying not only the common and external carotids, but also the superior thyroid. While it is not improbable that the tying of these three vessels at one sitting has been done before for internal carotid aneurysm, I have not found the record of it. The whole operation can easily be done through one incision. What little danger there

is from secondary hemorrhage at the site of operation is minimized by this procedure.

Robert D., aged twenty-two years, farmer. Entered the Jewish Hospital, February 3, 1906. Was referred by Dr. Vail. Father and mother both living; three brothers and two sisters living and well. The patient had one attack of appendicitis in 1895, but has had no recurrence. Was perfectly well until the onset of the present trouble. This began shortly after a fall sustained on the 18th of October, 1905, which resulted from a slight blow on the head during an altercation. The blow was delivered over the right temple, and was followed by an attempt at gouging the eyeball from its socket. This happened about 4 P.M. The patient was not rendered unconscious or dizzy. He walked home, and felt well until about four hours later, when he began to vomit. The vomiting lasted only a short time. He had no further evidence of anything wrong until the 28th of November, when he suddenly noticed that he was unable to see out of his right eye, and that the eye became very much reddened and swollen. From this time forth the eyeball became more and more prominent, until within two weeks of the onset of symptoms he was unable to close the lids. Occasionally he suffers from pain in the forehead, but he suffers mostly from ringing, buzzing, and blowing noises in his head.

Physical Examination. Well-developed male. Well, except for condition of his right eye, which projects between the palpebral fissure. The conjunctiva is intensely reddened and of uniform velvety appearance. The cornea is in a marked depression formed by the rim of the conjunctival attachment. The cornea is clear. There is an absolute paralysis of the abducens. Over the inner portion of the upper lid, and in the supraorbital territory, extending for about two inches above the ridge, there is a distinct pulsating swelling. It is evidently expansile, and on auscultation presents a loud, rasping bruit synchronous with the cardiac systole, and disappearing entirely on compression of the carotid artery in the neck. There is no discoloration of the skin. The upper lid, the eyeball, and the swelling above alluded to are exquisitely sensitive to the touch. According to Dr. Vail, the ocular media are perfectly clear. The veins are shown to be about three or

four times their normal size, and occasionally are seen to pulsate. I am indebted to Dr. Vail for the accompanying diagram of the ophthalmoscopic picture. The general condition of the patient is normal, although his rest is very much disturbed by reason of the continuous noises, which are particularly annoying when the patient lies down. What sleep he gets is in a semirecumbent posture.

Diagnosis. Arteriovenous aneurysm of the internal carotid, traumatic in character, with rupture of the abducens.

Photograph of patient.

Operation. February 7, 1906. Gas-ether anesthesia. Incision four inches long, along the entire border of the sternocleido. Exposure of the carotid sheath at point of election and division of the common artery between two catgut ligatures. Exposure further upward of the external carotid artery and of the superior thyroid artery. Ligation of the external carotid between the facial and the superior thyroid. Division of the superior thyroid

between two ligatures. After closing the incisions in the arterial sheaths with fine catgut, the wound was closed with buried sutures and skin-clamps. The patient left the hospital seventeen days after the operation. There was no recurrence of the pulsation. The eyeball had receded very much, although not entirely. The conjunctival chemosis had entirely disappeared, so that, except for a considerable number of tortuous veins, the sclerotica presented an almost normal appearance. The paralysis of the external rectus continued as before the operation. I saw this patient three months and a half after the operation, and his condition remained unchanged, except for a recession of the exophthalmos and yet a closer approach to the normal appearance of the sclera. The abducens paralysis persists. There is no pulsation in either the temporal or facial artery of the affected side. According to Dr. Vail, the vision has improved very much, although there still remains a very marked tortuosity and distention of the intraocular veins. Along the inner portion of the supraorbital ridge there is a slight depression, as from absorption of bone. An effort to demonstrate this by radiograph failed. The patient is following his usual vocation, which necessitates work of the hardest kind.

Addendum. In a note from Dr. Vail dated May 28, 1906, he writes that the large central scrotoma, which the patient had before the operation, and which permitted him to see fingers only near the eye when held to one side, has disappeared. The neuritis from which the patient suffered has been completely recovered from, and the vision is now 20/20. He reads the finest print.

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CASE OF TRAUMATIC HEMORRHAGE INTO THE LEFT LATERAL LOBE OF THE CEREBELLUM, TREATED BY OPERATION; RECOVERY.

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The patient was a boy, aged twelve years, and was admitted into hospital four years ago suffering from severe headache, giddiness, frequent vomiting, unsteadiness in gait, and some weakness in the left leg, these symptoms having been present for a fortnight. There had been no fits, but the boy had become very drowsy the last two days. The only history bearing on the condition was that two months previously the boy had fallen on his head off another boy's back. His head struck the ground over the parietal eminence of the right side. He was somewhat stunned, but was able to walk home with assistance; the nose bled for a short time, but otherwise he appeared to be unaffected by the fall. There was no vomiting, and he was up and about the next day as usual.

Upon admission the boy was in a condition of "cerebral irritation," lying curled up in bed on his left side, with hips and knees flexed, eyes tightly closed, and he resented being spoken to or interfered with in any way. Any attempt to retract the neck appeared to cause much pain. The temperature was 100°, pulse 80 and regular. The pupils were equal and of medium size; both reacted well to light and accommodation; there was no ophthalmoplegia, but well-marked double optic neuritis.

There was great difficulty when he attempted to walk; he took short, unsteady steps, reeling from side to side and dragging the left foot; there was a tendency to fall backward and to the right. There was distinct weakness and some inco-ordination

of the left arm and weakness of the left leg, but the face was unaffected. The left knee jerk was a little exaggerated, the right diminished; there was no ankle clonus. The cutaneous reflexes were present and equal; there was no anæsthesia. Vomiting was frequent.

Upon trying to sit up he complained of severe frontal headache and giddiness. When giddiness was present the objects in the room appeared to move across him from left to right, and he himself seemed to be going in the same direction. This particular observation is in accordance with the clinical results obtained by Stewart and Holmes, and published recently in *Brain*, that in intracerebellar lesions external objects appeared to move from the side of lesion to the normal side, and that the sense of movement of the individual was in the same direction as that of the external objects, whereas in an extracerebellar lesion the sense of personal movement was in the opposite direction to that of the external objects.

He was kept under observation in the medical ward for ten weeks. At the end of the first fortnight some weakness was apparent in the lower part of the face on the left side, lateral nystagmus to the left developed, and there was paresis of the conjugate movements of the eyes to that side; there was no squint. The sight became progressively worse, and finally he was not able to read one-half-inch type at fifteen inches; this should have been possible at nine yards.

The inco-ordination in the left arm on purposeful movement and the weakness increased, so that he was only just able to raise that hand above the head. He vomited every day, often many times a day, and complained of much headache.

During the latter part of the time the patient was under observation he improved considerably in so far that the headache, giddiness, and vomiting almost entirely disappeared, but the weakness of the limbs on the left side and the difficulty in walking remained.

An operation was performed five months from the receipt of the injury. An opening in the bone over the left lobe of the cerebellum was made, measuring two and one-half by two and one-quarter inches. Owing to the free hemorrhage and some

embarrassment of respiration during this procedure the skin-flap was then replaced and the dura mater left intact.

A fortnight later the wound was again opened up and a flap of dura turned down. The cerebellar substance immediately bulged freely through the opening. The outer surface of the cerebellum as far forward as the posterior surface of the petrous was thoroughly examined, but no tumor found between it and the dura. The little finger was then thrust into the substance of the lateral lobe, and at a depth of one and one-quarter inches a soft smooth rounded body could be felt about one and one-quarter inches in diameter and not incorporated with the surrounding brain substance. Enucleation with the finger was attempted, and rather more than half of the circumference had been separated from its bed when the tumor was felt to give way, and dark, almost black, clot came out along the track made by the finger. Decolorization was commencing in this clot; there was no capsule to the mass. The whole of the clot was removed and no evidence was found that the case was one of hemorrhage into a new-growth. After the removal the cerebellum receded within the skull to a depth of three-fourths of an inch. The dura and the skin-flap were then sutured in position. Before the clot was enucleated the respirations were very shallow and showed signs of failing altogether, but they at once improved after the clot had been let out.

The boy made a slow but uneventful recovery, and three months after the operation could walk without unsteadiness, and the sight was rapidly improving. All headache and giddiness had disappeared.

At the present time, four years after the operation, the boy is in excellent health—in walking he can turn suddenly round without reeling—there is still a slow laternal nystagmus of large excursion to the left, that is to the side of lesion, and oscillation is also present on upward movement of the eyes. Vision is almost normal in each eye. The grip of the left hand is weaker than that of the right; dynamometer, right 65; left 50. A little inco-ordination is still present in the left arm on intentional movement. Power in the legs is equal on the two sides, the knee jerks are equal and there is no ankle clonus.

Remarks. Primary apoplexy of the cerebellum is exceedingly rare as compared with that of the cerebrum. Of ninety-six consecutive cases of apoplexy occurring in a large London Hospital in only one case was the hemorrhage confined to the cerebellum. Almost all recorded cases of cerebellar hemorrhage are due to disease, and in a hurried look through some of the literature of the subject, which I regret has not been by any means exhaustive, I have only found one case of primary intracerebellar traumatic hemorrhage, and no instance of such a case being submitted to operation. The case in point was published by Dr. Ratcliffe in the *Birmingham Medical Review* for 1894. It was that of a boy

Horizontal section of cerebellum. Diagram showing site and extent of lesion.

of ten who fell from a four-foot wall on to his head. He walked home twenty minutes later and complained of great pain and tenderness over the back of the head on the left side—he vomited frequently. There was no external injury to the head or paralysis of arms or legs. He died of failure of respiration four and one-half hours after the accident. At the necropsy there was found a hemorrhage into the middle lobe of the cerebellum three-quarters of an inch in diameter; this had burst into the fourth ventricle and had extended into the third and lateral.

In most of the cases of cerebellar hemorrhage the extravasation is extensive, and it would appear that the superior cerebellar artery is the vessel most liable to rupture. The pressure of the blood is so great that the pons on the same side is not infrequently affected and paralysis on the opposite side of the body results, as has been recorded in some of these cases. Thus, a sudden hemorrhage into the cerebellum may differ from a slow growing tumor as regards the side on which the paralysis is found, although one case is recorded by Dr. Thacher in the *Proceedings of the New York Pathological Society*, vol. xv, of a spontaneous hemorrhage into the left lobe of the cerebellum of a man, which caused paralysis of the limbs on the same side of the body.

The rarity of my case is hardly the reason for recording it, but I bring it before this meeting more for the purpose of drawing attention to the fact that a hemorrhage into the brain may exactly simulate a new-growth, and that paresis of the homolateral limbs, weakness of the conjugate movements of the eyes, and lateral nystagmus to the same side may be valuable localizing signs of cerebellar disease.

The latent period of six weeks from the accident to the onset of symptoms should be noted. It is well known that hematoceles in various parts of the body, such as those in the tunica vaginalis, the pelvic peritoneum, and the cerebral meninges, often increase in size by successive small hemorrhages.

Is it not possible that in this case the onset of the symptoms six weeks after the accident was due to a small fresh hemorrhage taking place at that period?

Some brain operations, although very difficult in anticipation, turn out to be very easy in performance, a consideration which should debar us from refusing the relief which surgery may afford to sufferers from intracranial disease.

HYPERPLASTIC TUBERCULOSIS OF THE INTESTINES.

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AND
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My main object in presenting this paper is to put on record another instance of that rare manifestation of tubercle in the intestinal tract, the hyperplastic form, occasional instances of which have been reported during the past fifteen or eighteen years. The only account of such a case noted in this country, that I have been able to find, after a cursory study of the literature, is one by August J. Lartigau, of New York City, published in the *Proceedings of the New York Pathological Society* for 1900 and 1901, pp. 103 et seq.

I shall present a brief historical account of the cases reported by various authors, without following an absolutely chronological order.

The sources from which I have drawn this information are the article by August J. Lartigau, already mentioned, and the thesis for the doctorate in medicine of Ernest Motel, presented in February, 1900, entitled "Étude de la Tuberculose de l'Intestin Grêle à Forme Hypertrophique."

It is most difficult, and sometimes impossible, to determine whether Motel is reporting cases of the genuine hypertrophic form, or merely those where much thickening from the cicatrization of tubercular ulcers has supervened. Having been unable to consult the original articles, I shall give a list of Motel's cases and append his bibliography, which probably comprises all of any importance of Continental origin up to 1900. Doubtless a longer search through the literature would result in unearthing

a few additional cases, but a study of Lartigau's and Motel's writings, with Dr. Butterfield's remarks in this paper, will supply all the information requisite concerning every form of intestinal tuberculosis from the clinical as well as the pathological standpoint.

Leudet, in 1853, presented to the Société Anatomique a tubercular tumor of the duodenum, and in 1874 a specimen of a tubercular stricture situated at the junction of the upper and middle thirds of the small intestine. Spillmann, in 1881, devoted his Thèse d'Aggregation to tuberculosis of the intestinal tract, but it is doubtful if he was acquainted with the true hyperplastic form. Koeberle, in 1881, removed two meters of the small intestine on account of four strictures resulting from ulceration of Peyer's patches, which Motel thinks may have been tubercular, but neither of these cases can be with any certainty determined to be of the hyperplastic form, although they may have been. To the same doubtful class belongs a case of resection for stricture performed by Dezanneau in 1891. In 1888, Girode (Thèse, Paris) dealt with intestinal tuberculosis, but appeared not to have met with a case of the hyperplastic form. In 1889, Souchier and Hacker report (according to Motel) cases operated upon where the tumors situated in the ileocæcal region so closely simulated carcinoma (as mine also did), that only the microscope could determine their tubercular nature. Darier, in 1890, found, postmortem, eight valvular, diaphragm-like strictures in the course of the small intestine, the uppermost being situated near the duodenum, the lowest just above the ileocæcal valve, the total length of the small intestine being reduced to four meters. From the record it cannot be determined whether the strictures were due to the hyperplastic form or not. G. Lyon, in the *Gazette des Hôpitaux*, No. 139, 1891, published a paper in the *Montpellier Médical* on the sclerosing process sometimes following tuberculosis of the intestine and leading to stricture formation. About this period the writings of Baillet, Mockenhaupt, Zimmerman and Becker may be consulted with profit. During 1892, Le Bayon, in an inaugural thesis, writes of tubercular typhlitis, but I cannot ascertain whether any of these writers reported new cases of hyperplastic tuberculosis, or merely wrote papers on this subject founded on the

observations of others. Czerny and Salzer, in the same year (1892), report some cases, according to Motel, but I have not seen the original paper; hence I am in doubt as to the exact form of tuberculosis. Benoit, in 1893, collected and published most of the facts previously known concerning intestinal tuberculosis. Dupont, in 1894, continued this study, eliminating, however, for his purposes, primary tuberculosis of the intestine, considering this purely surgical. He recognized the occurrence of the hyperplastic variety, which he stated was often confounded with carcinoma, and that this form is commonly seen in patients absolutely free from pulmonary tuberculosis. Coquet, during the same year, presented an inaugural thesis describing the neoplastic variety of tuberculosis, remarking that this is frequently confounded with other neoplasms, its tubercular nature being overlooked unless microscopical examination is made. In 1893, Baillet, in a paper dealing with resection of the intestine, concludes that this operation in the ileocecal region is the operation of choice for tubercular stenoses, quoting Mockenhaupt, Zimmermann and Becker. Creikx (Société Belge de Chirurgie) contributes a paper on tubercular intestinal stricture which probably does not deal with the hyperplastic variety. Sourdille, in 1895, recognized that cylindrical stricture of the rectum was often tubercular, he being the first to describe this condition as a true tubercular neoplasm, and pointed out that a rectal stricture, when not congenital, is not necessarily syphilitic, but may be tubercular. Hofmokl, probably, also observed the hyperplastic form about this time. Goshel, Weisinger, and Korte then studied this question of tuberculosis of the intestines. Hoffmeister next called attention to tubercular strictures of the intestines, founding his paper on twenty collected cases, including one of his own. Twelve of these were operated upon and eight found at postmortem. Boschgrewink, Lennander, Prochwink, and Schiller report cases. During 1897, Riche and Chavannez reported several cases, soon followed by others by La Pointe, Bezançon, Carel, and Claude. Itié, at Montpellier, published, in 1898, a thesis on hypertrophic tuberculosis of the intestines. Bernay's thesis, delivered at Lyons in 1899, deals with the same subject. Guinard showed to the Société de Chirurgie, March 22, 1900 (?), a specimen of the same

nature, and Tuffier, on May 10th, exhibited to the same society a specimen of a similar character. Finally, Monnier published in the *Archives provinciales de Médecine*, 1899, a case upon which Motel founds his thesis, antedating the last two reports in its performance, as the case was operated in 1894, although not published until 1899.

I shall take the liberty of condensing the clinical history of Dr. Lartigau's case, supplied him by the patient's attending physician.

S. C., male, aged forty-nine years, had been compelled to abandon his business shortly after the onset of his trouble, three years before his death. His family and personal history were negative. Without apparent cause, he lost weight and strength, so that the slightest exertion induced partial syncope. The skin became darker and almost uniformly bronzed. About two months after the commencement of his illness, he suffered from frequent, universal, non-localized, cramping abdominal pains, although he sometimes "fancied they were most intense in the right iliac region." Primarily, the attacks were of short duration, lasting only five minutes, and appearing irregularly at intervals of about one week. Later, the attacks would last for half an hour or longer, and would recur four to eight times daily. They seemed to bear no distinct relation to the ingestion of food on the one hand, or an empty condition of the stomach on the other. Vomiting occurred from time to time, especially during the painful paroxysms. All the symptoms steadily increased in severity, and poor appetite, with alternating constipation and diarrhœa, was noted, there having been throughout the illness a tendency to the latter. No blood was detected in the stools, nor could any abdominal tumor be palpated.

Eighteen months before death he first received medical treatment. He then stated he had lost thirty pounds in weight during the first year of his illness and was exceedingly weak. The deep generalized pigmentation mentioned was present, but the conjunctivæ and mucous membrane of the mouth were free from pigmentation and were pale. No fever was present. Nothing abnormal was detectable in the abdomen, beyond some tenderness on deep palpation, especially in the right iliac fossa. The spleen was not palpable. The superficial lymph-nodes were nowhere

enlarged. The diagnosis of Addison's disease was made, and under treatment addressed to this condition, the patient improved slightly, putting on some flesh, while he had less abdominal pain. Following this improvement his symptoms became aggravated, an evening rise of one or two degrees F. above the accepted normal being observed. Attacks of syncope, so easily induced as to compel his remaining in bed most of the time, commenced to be common about two months before his decease. A few days before death, right-sided lobular pneumonia developed, hastening dissolution.

In Dr. Lartigau's case the postmortem examination revealed no adhesions between the small intestines. When the upper third of the ileum was reached, "a noticeable increase of the thickness of the wall became apparent," the tissue feeling firmer and more stiff than normal, until, when the mid-portion of the ileum was reached, the bowel was a non-collapsible, firm tube, the resistant wall measuring at the junction of the middle and upper thirds of the small intestine 4 to 7 mm. in thickness. As the ileocæcal region was approached, the thickening of the walls steadily increased until in the last 30 to 40 cm. it measured 1 cm. The walls of the caput coli, which was bound down by old adhesions, measured 2.7 cm.; the ileocecal valve was also thickened. The walls of the ascending colon measured 1.2 cm. below, but thinned out to 0.75 cm. at the hepatic flexure. The transverse colon maintained about the same thickness (0.75 cm.), but the descending colon gradually thinned out until it reached its normal condition when the sigmoid flexure was reached.

Section of the hard walls showed them to be of a gray-whitish color, and they seemed macroscopically to be composed of fibrous tissue. The thickening seemed fairly uniform, except the posterior wall of the cæcum, where it was fully 1 cm. thicker than anteriorly, in decided contrast to the irregular thickenings described as present in my specimen. Neither tubercles nor caseated areas were detected, and, except in the last 40 cm. of the ileum, the caliber of the bowel seemed unaltered; here it was lessened "by about one-third." The same was true for the colon until the transverse portion was reached, when, *pari passu*, with the decrease in thickness of the bowel-walls, the lumen increased, to attain the normal when the sigmoid flexure was reached. No

ulcerated areas were observed, the mucous membrane seemed to be normal, although somewhat pale in the upper ileum, but gradually became thickened with the induration of the other coats, and conversely thinning out as they became more and more normal. The same remarks apply to the mucous membrane of the large bowel. Papillomatous masses were noted projecting from the mucous membrane, averaging 4 or 5 mm. in length, which were

FIG. 1.—Hyperplastic tuberculosis, taken from centre of tuberculous mass.

most numerous in the lower ileum, but were apparently absent in the upper portion of the small bowel. Microscopically, "the mucosa was thickened, about four or five times beyond the normal." This thickening was largely due to massive infiltration with round cells. The surface epithelium looked normal. The papillomatous outgrowths were directly continuous with the submucosa, and present the same general round-cell infiltration observed

throughout the various layers. They further contained unstriped muscle fibers continuous with the muscularis mucosæ. The submucosa presented the greatest degree of round-cell hyperplasia; a similar infiltration also existed in the muscular zone. No histological tubercles were observed, but sections stained for tubercle bacilli revealed great numbers, especially in the mucosa and submucosa.

It is interesting to note that tuberculosis of the suprarenal capsules existed, which accounts for the bronzing of the skin and some of the other symptoms of Addison's disease, all of which were absent in my case. It is needless to say that the mesenteric lymph-nodes were also tubercular. The other postmortem findings have no bearing on the intestinal condition, hence they will be omitted.

The essential points in the history of my case can be briefly stated, while the operative technique being in no way peculiar, the details will not be described.

E. H., aged thirty-nine years, married, American, by occupation a stationary engineer, of good personal habits, was admitted to the University Hospital May 22, 1905. His family history was free from any hint of tubercular predisposition. He had had the usual diseases of childhood, with satisfactory convalescence. He had had one attack of gonorrhœa twelve years ago, from which he had recovered in about six weeks, since which time, until the onset of his present ailment he has remained perfectly well. The diagnosis was tumor of the cæcum, which was probably malignant, and possibly tubercular, as had been suggested by his physician.

He had first noticed the present trouble during August, 1904, having had an occasional "stomach-ache," occurring during the latter part of the day. One afternoon (the date could not be recalled) during the latter part of November, 1904, he was suddenly attacked with severe abdominal pain, located in the right side and epigastrium, which was followed by violent emesis. Returning home, he again vomited freely, after which the griping abdominal pain ceased, he being able to sleep through the whole night in comfort. He remained well until Christmas, when he had such severe diarrhœa that he consulted a physician on January

2, 1905, who detected a small right-sided tumor in the abdomen, which he could not find at the next visit, January 23d, but did palpate on a subsequent occasion, about the middle of February, 1905. The physician then thought the mass larger, and the patient was satisfied that it steadily continued to enlarge up to the time of his admission to the hospital. Weakness and some loss of flesh, with occasional aching pain in the epigastrium and in the region of the tumor, was all the patient complained of on admission. There was no fever. The attacks of vomiting had

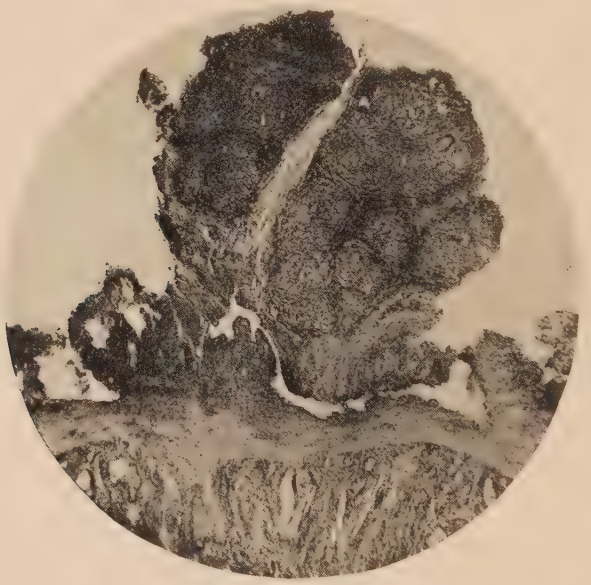

FIG. 2.—Hyperplastic tuberculosis showing characteristic villous formation on serosa.

not been repeated since November, but he had had one or two attacks of diarrhœa, each lasting for two days.

Operation May 25, 1905. The incision was made through the right rectus, and a tumor such as Dr. Butterfield describes was delivered and removed, the division of the colon being about 5 cm. above the termination of the cæcum, while the small intestine was resected approximately 80 cm. above the ileocæcal valve, the

length of both bowels removed being 92 cm. Most of the small intestine removed was apparently free from disease, but distinct areas were markedly infiltrated, necessitating either numerous resections, which would have been most unsurgical and apt to lead to gangrene, or the extensive excision I was forced to make. Union was effected by circular enterorrhaphy, and a small cigarette drain was employed. Recovery was rapid, interrupted by the formation of a slight fecal fistula, which eventually closed, but the drainage tract remained open until the man's death. He was discharged August 12, 1905, and returned to his work, the sinus discharging a very small amount of pus. The cervical lymph-nodes were enlarged, and continued to increase in size after leaving the hospital. In November, 1905, he began to develop temperature, the larynx became seriously diseased, and he died exhausted about two months after his laryngeal symptoms appeared. A curious incident was the apparently complete disappearance of the enlarged cervical lymph-nodes about two weeks before death, this process occupying only some ten days. One week before death a slight fecal fistula formed at the site of operation. No postmortem examination was made.

The possibility, nay, the probability, of mistaking this disease for carcinoma, and thus perhaps being deterred from successful operative interference, is an additional reason for reporting my own case, which has already been published elsewhere as one of a series illustrative of intestinal surgery.

The striking peculiarity, the essence of this tubercular manifestation, is the marked thickening of the intestinal walls, extremely well shown in my own case, and which led French writers to term the condition "tuberculose intestinale à forme hypertrophique." Its point of election is the ileocecal region, although it has been seen elsewhere. The disease appears to involve readily and extend along any coils of bowel which become adherent to the primary lesion, leaving intervening healthy portions, as in my case, for it extends widely in both directions from its point of origin, as shown in Dr. Lartigau's case. Dr. Lartigau's specimens differed markedly from mine and others quoted by Motel, as will be seen when comparing the abstract of his case and the description given by Dr. Butterfield of my specimen.

Macroscopic Description of Dr. de Nancrède's Specimen. By Dr. E. E. Butterfield. (From the Pathological Laboratory of the University of Michigan. By permission of Prof. A. S. Warthin.) This consisted of 92 cm. of the small intestine, together with the caput coli and a portion of the ascending colon. The appendix was directed posteriorly, its upper two thirds being firmly bound down. In the ileum, just at its junction with the cæcum, there was an encircling band 6 cm. broad. It was composed of small nodules. The intestinal wall at this point was thickened to the extent of from 5 to 7_2 mm. On section, the individual nodules, as well as the wall of the gut, were grayish white, glistening, translucent, and homogeneous. There were five other similar encircling bands in the 85 cm. of ileum. Between these bands the gut was apparently normal, but on close inspection there were seen beneath the serosa a few pin-point to pin-head semitranslucent areas. The lymph-nodes about the caput coli and the mesenteric nodes were about the size of hazelnuts, and on section were firm, homogeneous, grayish white, and glistening. The mesentery, especially in the vicinity of the encircling bands, was studded with nodules of various sizes, many of which had long, slender pedicles. The small vessels in the mesentery and subserous tissue were injected and small hemorrhages were seen at frequent intervals. The mucosa corresponding to the girdles of new tissue was not ulcerated, but through it could be seen small semitranslucent bodies of about the size of a pin's head.

Microscopic Appearances. Sections from the annular constrictions in the intestinal walls show a diffuse invasion of the muscular and submucous coats with epithelioid tubercles. The tubercles are rich in fibrous tissue cells and giant cells, but there is hardly a trace of caseation. The overlying mucosa is atrophic, but is continuous and free from ulceration. The subserous connective tissue contains closely packed epithelioid tubercles, and the small pedunculated nodules studding the peritoneal surface of the gut, which were so numerous in the gross specimen, are seen to be made up of similar tubercles.

The lymph nodes in the region of the cæcum, and the mesenteric nodes, are almost entirely replaced by small confluent tubercles.

The tubercles are of the same type as those in the intestinal wall; *i. e.*, they are composed chiefly of fibrous tissue elements, epithelioid cells and giant cells. Only in the greatly enlarged glands is there a trace of caseation.

The intestine between the tubercular constrictions is practically normal, save for slight atrophy of the mucosa and scattered subperitoneal tubercles.

Diagnosis. It is a matter for regret that a study of the clinical histories of these two cases with those furnished by Motel reveals so little of distinct value for the diagnosis of cases of a similar nature. The existence of the disease can only be determined after a most careful consideration of all the symptoms presented, and its existence must be inferred rather than positively affirmed. Many of the symptoms are common to a number of affections, such as abdominal tumors, intestinal obstruction, appendicitis, ulcer of the stomach, tubercular peritonitis, affections of the right kidney, and of the tubes and ovaries in the female. The symptoms most commonly observed are weakness and loss of flesh, lasting over a long period; the evolution of the condition, although continuous, being slow, and possibly dependent upon a bacillus of attenuated virulence. Painful crises are usually noted, due to the arrest of the intestinal contents at the strictured points, with localized distention, possibly, with visible peristalsis of intestinal coils, the result of localized tympany. These attacks are followed by cessation of the pain after characteristic borborygmi are heard, due to the passage through the obstruction of gas—sounds, as König says, somewhat like those produced by suddenly forcing fluid through a syringe. These attacks of colic may or may not be attended by vomiting, this symptom being of course commoner in the later stages of the disease, when obstruction of the bowel to a greater or less degree exists. Moderate constipation in the early stages, with occasional attacks of diarrhœa, are common, but the latter symptom may not be more pronounced and persistent than is often accidentally present in individuals without any intra-abdominal lesion. This was true of my patient and of others quoted by Motel. Except in the latest stages, the vomiting suggests neither distinct intestinal obstruction nor appendicitis. There is no characteristic painful point, and there is absence

of all general distention and of the fever so common in even slight cases of appendicitis. The tumors are more or less mobile, steadily increase in size, are often multiple, and are apt to assume a cylindrical form; they are usually tender when gently palpated. If the patient be a male, of course all question of uterine, ovarian, or tubal tumors is at once disposed of. A steadily increasing tumor or tumors remaining fairly mobile for long periods without generalized distention, fever, or leukocytosis would be against the presence of appendicitis, but would equally suggest malignant disease, especially if some difficulty were experienced in securing proper alvine evacuations. The differential diagnosis must be made chiefly from malignant tumors of some abdominal organ. The coexistence of pulmonary lesions seems very exceptional. It is true that these tubercular conditions are more prone to occur at an earlier age than carcinomatous disease; nevertheless, so many young individuals do suffer from malignant tumors that this point is only of relative value. Should a careful study of the symptoms indicate the possible presence of a tubercular lesion, a resort to the tuberculin test should settle the question.

Treatment. This resolves itself into excision of the affected portion of the bowel. Doubtless, fresh air, sunshine, tonics, and the ordinary measures addressed to the treatment of tuberculosis located elsewhere, may serve as roborants, and increase the peritoneal tissue resistance, as well as that of other parts, but no direct effect can be expected, as is the case in certain instances of ordinary tubercular peritonitis.

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Tubercular stricture of the small intestine, with operation. Frank, Edouard. Op. cit.

Two tubercular strictures of the ileum; double resection, with recovery. Vohtz. Op. cit.

Resection of small intestine for tubercular stricture of the small intestine. Recovery. Salomoni. Op. cit.

Multiple tubercular strictures of the ileum. Resection and recovery. Lennander. Op. cit.

Tubercular stricture of the intestine. Resection; recovery (?). Cotterill. Op. cit.

Four tubercular strictures of the small intestine; extensive resection. Recovery. Troje. Op. cit.

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SURGERY OF THE SPINAL CORD.

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Without a clear-cut thorough knowledge of the anatomy of the the cord, first, as to its various columns and their locations; second, as to the location of the ganglion—of trophic cell body—of the axones—which make up these columns, and which indicates the direction of the line of degeneration; third, as to the origin of the axones either in the spinal cord ganglion cells or in the spinal posterior root ganglia and their directions; fourth, as to the position of acquirement of the medullary sheath and neurilemma in or outside of the cord; fifth, as to the relation of the entrance of the nerve roots into the anterior and posterior lateral fissures and the topographical relation of the spinal foramina to the point of entrance of fibers into the lateral fissures and thence to the various segments of the cord; sixth, as to the ependyma in its anatomic and pathological relations to the substance of the cord; and as to the essential genetic and histological difference between the cauda equina and the remaining portion of the cord; all effort of understanding or advancing the surgery of the spinal cord is futile. We must, therefore, devote a considerable space to these details, and solicit the indulgence of our readers for entering into such minute descriptions.

The neurone theory is herein appropriated for the interpretation of the histology, physiology, clinical manifestations and pathology of the nervous system, and is particularly applicable to a knowledge of its surgery, notwithstanding the recent divergencies of theory as to "peripheral regeneration."

SYNOPSIS.

1. What lesions of the spinal cord are amenable to surgical treatment?
2. What lesions are not?
3. What is the histological basis?

SYNOPSIS FOR SURGERY OF THE SPINAL CORD.

- **Anatomy (Gross).**
  - Neurone, nervous unit.
    - Neurilemmic degeneration.
    - Aneurilemmic degeneration.
  - Spinal cord.
    - Medullated. — Insulation.
    - Non-medullated. — Effect.
  - Medulla Oblongata.
    - Position of neurones separated from cell body.
  - Cauda Equina.
- **Minute anatomy.**
  - Columns.
  - Fasciculi.
  - Gray matter.
    - Arrangement; origin and termination of neurones. (*a*) Motor. (*b*) Sensory.
    - Conformation; structure. Cranial.
- **Topography of**
  - Motor. Ependymal canal.
  - Nuclei.
  - Sensory.
- **Macroscopical and microscopical description of**
  - Anterior (motor) roots. — Extraspinal / Intraspinal — Centrifugal impulses.
  - Posterior (sensory) roots. — Extraspinal / Intraspinal — Centripetal.
  - Spinal ganglia. Location; structure.
  - Cranial ganglia.
- **Location of trophic ganglion cell body.**
  - Motor nerves.
  - Sensory nerves.
  - Sympathetic.
- **Degeneration of spinal cord after division.**
  - Ascending (sensory); descending (motor); zonal.
    - Anteropoliomyelitis. Trauma.
      - Ganglionic cells destroyed.
  - Description; histological evolution of degenerative process.
  - Conclusion.
- **Nerves.**
  - Cerebral.
  - Cranial.
  - Spinal.
- **Degeneration of**
  - Anterior (motor) roots. (Charles Ballance.) (Purves Stewart.)
    - Extraspinal.
      - Cerebral nerves.
      - Four sensory.
    - Intraspinal.
      - All cranial nerves except above practically spinal.
  - Posterior (sensory) roots. — Extraspinal. / Intraspinal. — Spinal
- **Regeneration of spinal cord after division.**
  - Historical: Is there regeneration of sensory root? See Frazier and Spiller's trifacial case.
  - Errors in Surgical Reports. Not a single recorded case of functional restoration—*aneurilemmic* axone.
  - Experimental studies.
  - Is regeneration of spinal cord possible?
    - Partisans (Marinesco, Stroebe).
    - Opponents.
  - Conclusion: Cannot be; will not be

- Regeneration.
  - Electric faradic reaction.
  - Anterior (motor) roots.
    - Intraspinal.
    - Extraspinal.
  - Posterior (sensory) roots.
    - Intraspinal.
    - Extraspinal.
- Diagnostic significance in pathology.
  - Size of ganglion has a direct relation to the regenerative potency.
- Surgical interventions and limitations in
  - (*a*) Compressions.
  - (*b*) Concussions.
  - (*c*) Dislocations.
  - (*d*) Contusions.
  - (*e*) Fractures.
  - (*f*) Bullet wounds.
  - (*g*) Punctured wounds.
  - (*h*) Partial or complete transverse sections.
  - (*i*) Syringomyelia; spina bifida.
  - (*j*) Motor paralysis of lower extremities.
    - Anterior poliomyelitic.
    - Hemiplegia.
      - (*a*) Central.
      - (*b*) Spinal.
  - (*k*) Hemorrhage. Extraspinal; intraspinal; spinal puncture.
  - (*l*) Tumors; paralysis.
    - Degenerative.
    - Functional.
  - (*m*) Tuberculosis.
    - Spinal column.
    - Spinal cord.

NEURONE.

A neurone consists of a cell body, its trophic ganglionic cell; of an axone or axones and of dendrites and telodendrones. The intraspinal axone is composed of an axis cylinder and medullary sheath, the extraspinal one has in addition a neurilemma. The sympathetic axones, except a few abdominal fibers, have no medullary sheath, but have a neurilemma.

ANATOMY (GROSS AND MINUTE).

From a surgical standpoint the spinal cord commences above or on a line between the articular surface of the atlas and the condyles of the occipital bone. Anatomically its lower limit is the apex of the conus medullaris, which is situated at the upper level of the second lumbar vertebra. Surgically, however, the lower limit is one to one and a half inches above this point, bringing it to the twelfth dorsal, as the sacral and coccygeal nerves originate from the side of the conus up to the level of the eleventh dorsal vertebra. The upper limit is an arbitrary one, corresponding to the decussation of the pyramidal tract. Anatomists differ in their description of the limitations of the conus. Fitzner con-

siders its upper limit a line passing immediately below the point of origin of the coccygeal nerve. Poirier places this line above the origin of the first coccygeal nerve, just below the origin of the fifth sacral. This varies, in children it is as low as the second lumbar; in adults it is as high as the eleventh dorsal.

The cauda equina is a group of nerves which supplies the inferior extremities, buttocks, bladder, and genitalia. It is enclosed in a fibrous muff of the dura mater, which terminates in a cul-de-sac on a level with the second sacral vertebra. The exit of the lumbar and sacral nerves is through the side of this sac, while the filum terminale and coccygeal nerves pass through the apex of the cone. The openings in the dura for the exit of these nerves are very much lower than the exit of the nerves from the anterior and posterior lateral fissures of the cord. The cord is held in a fixed relation with its bony canal by the ligamenta denticulata and the spinal nerve roots; above, it is suspended from the medulla, and below it is attached to the posterior surface of the coccyx by the coccygeal ligament, which is a continuation of the dura. The cord is composed of two halves, produced by the deep anterior and posterior fissures, which separate it into lateral halves for three-fifths of its diameter.

On both sides, external to the posterior fissure, there is another fissure, the sulcus lateralis posterior, in which are implanted the posterior sensory roots. This fissure subdivides the cord into a small posterior and a much larger anterolateral column. The two posterior columns thus formed are paths of sensory neurones. The anterolateral column is subdivided by a fissure—sulcus lateralis anterior, in which are implanted the motor roots. The fissure is about the same distance externally from the median line as the sulcus lateralis posterior and subdivides the anterolateral white matter of the cord into sets of anterior and lateral columns. The posterior column is further subdivided by a groove into an internal fasciculus gracilis or column of Goll, and an external fasciculus cuneatus or column of Burdach. These columns, together with Gowers' and the small column of Lissauer, which applies itself close to the outer margin of the posterior roots, are the only sensory tracts of the spinal cord.

The anterolateral column is divided into anterior and posterior

sets of fasciculi. The anterior set is composed of (*a*) direct pyramidal tract; purely motor neurones which do not decussate in the bulb, and (*b*) the anterior ground bundle of short fibers connecting the spinal ganglion motor cells of different levels. The posterior set is composed of (*a*) the anterolateral tract; (*b*) the direct cerebellar; (*c*) the crossed pyramidal; (*d*) Gowers'; all of which surround the anterolateral ground bundles.

The gray matter has the aspect of a capital H formed by two lateral commas, connected by a transverse strand, the commissure. The gray matter is subdivided into anterior thick and posterior thin cornua. At the junction of these two there is a lateral expansion frequently called the lateral horn. At the tip of the posterior horn, the point of entrance of sensory neurone, there is a translucent substance called the gelatinous structure of Rolando. In the centre of the transverse commissure of gray matter there is a central canal which begins with an opening in the floor of the fourth ventricle, and ends blindly in the filum terminale. It is lined with epithelial cells, a continuation of the ventricular epithelium, both of which are ectodermic in origin. This canal has a great pathologic significance in syringomyelia, spina bifida centralis and central hydrocephalus. It is centrally situated in the lumbar region; in the dorsal and cervical it is more anterior; in the conus it forms a fusiform dilatation, 1 mm. in diameter, called the ventriculus terminalis of Krause. The gray matter of the cord is made up of ganglion cells, fibers, ground substance and stroma. Here are situated the trophic cell bodies of the lower motor neurones. The cells in the gray matter may be classified as follows:

First. Root cells:
- (*a*) Anterior root cells.
- (*b*) Posterior root cells.

Second. Column cells:
- (*a*) Anterior column cells.
- (*b*) Lateral column cells.
- (*c*) Posterior column cells.

The fibers originating from the column cells may be divided into:
- (*a*) Those passing in the white substance of the same side.

(*b*) Those passing in the white substance of the opposite side.

(*c*) Those passing in the white substance of both sides.

Third. Cells with short axis cylinders, association neurones:

(*a*) With fibers passing into the gray substance of the same side.

(*b*) Into the gray substance of the opposite side.

Surrounding the ependyma there are isolated ganglionic cells which send fibers to the same or opposite sides of the white substance. The ground substance or stroma, also called the neuroglia, is composed of delicate cells, which are distributed in both white and gray substances. There are two varieties: one the ependymal cells, already described, and the other, the neuroglia, Deiters' or spider cells. The latter have many projections which anastomose in various directions, forming a frame work which supports the delicate nerve tissues.

The fibers which make up the white substance or columns may be briefly classified as:

(*a*) Centripetal; long or projective axones; those which go from ganglia on the posterior roots and ganglion cells in the posterior horns of gray matter. (*a*) lower areas; (*b*) upper; areas in the cord, and medulla oblongata and cerebellum. (*b*) centrifugal; those which descend from the pyramidal cortical cells to the spinal ganglionic cells. (*c*) short axones; association neurones; which connect different levels of the cord with each other, and also the two halves of the cord at the same level.

Anterior nerve roots are the axones of the ganglionic cells of the anterior cornu. This cell body and axone form the lower or peripheral motor neurone of the first order (Barker). The cells of the anterior cornu are surrounded by two chief sets of "end brushes," one originating from the pyramidal tracts, the other from the posterior horn or roots. In this way cells in the anterior horn are in relation to the brain and periphery.

The axones from their motor ganglionic cells pass out of the gray matter into the white, where they immediately receive their medullary sheaths passing onward to the surface of the fissure where they receive their neurilemma. From here the fibers are

made up of an axone, a medullary sheath and a neurilemma, which continue to the muscle plate, where they lose their neurilemma and medullary sheath, the continuation being the axone subdivided into fibriles (telodendrons). All of the spinal nerves and all of the cranial nerves, except the nerves of special sense, have this anatomic structure. All axones supplied with neurilemma are, under favorable conditions, capable of complete regeneration. The trophic cell bodies of the lower motor neurones are located in the anterior cornu of gray matter. When the ganglion cells in the anterior column of gray matter are destroyed, as in anterior poliomyelitis, regeneration is impossible.

Posterior nerve roots are made up of efferent axones, originating from ganglionic cell bodies in the posterior root ganglion. The latter are the trophic cells of the posterior root as well as of the sensory neurones. The efferent axones enter the cord in the sulcus lateralis posterior, and divide in a T-like manner, one branch descending for a short distance, the other ascending for a longer distance, then they enter the posterior horn where they terminate in end brushes surrounding a nerve cell, which is the terminal nucleus.

The sensory neurone is made up of the ganglion cell (trophic cell) body in the posterior root ganglia, an efferent axone leading to the cord and on upward through the cord even to the cerebellum, as just described, and an afferent axone from the ganglion to the peripheral sensory corpuscles. Both of the axones have medullary sheaths and neurilemma, except the portion within the spinal cord, which has no neurilemma. The posterior root and peripheral axones are capable of regeneration.

The spinal, intervertebral or posterior root ganglia are ovoid swellings of grayish color with the long axis horizontal. They are situated within the intervertebral foramina with the exception of the ganglia of the first and second cervical and all of the sacral and coccygeal nerves. The situation of the first cervical ganglion varies; it may be inside, within or outside the dural opening; the latter most frequently. The second ganglion is situated between the anterior portion of the posterior arch of the atlas and the lamina of the axis, which represents the intervertebral foramen. The

sacral ganglia are situated in the sacral canal between the lateral wall of the canal and the dural cul-de-sac. The latter ganglia are, therefore, extra dural and interspinal. The ganglion of the coccygeal nerve is not constant. Every spinal ganglion is surrounded by a connective tissue capsule continuous with the perineural sheaths of the incoming and outgoing nerve roots. The body of the ganglion is divided and subdivided by septæ which originate from the capsule; these give support to the nervous elements. There are several types of cells in the spinal ganglion.

(*a*) Small and large unipolar, with Y-shaped or T-shaped division of their process. The cell body is either round or oval; from it, originates a single process, which becomes surrounded with medullary sheath soon after leaving the body. This makes several turns first, and then becomes straight. The branching of the process takes place, according to Dogiel, either at the second or third node of Ranvier, or not until it has reached the seventh node. One branch enters the peripheral nerve trunk as a medullated neurilemmic fiber; the other becomes also medullated for its entire extent and neurilemmic up to its entrance into the spinal cord. The cell body has a nucleated capsule which is continuous with the neurilemma of the single and bifurcated processes. In other words, the afferent and efferent axones are both provided with neurilemma.

(*b*) True intraganglionic cells; their processes do not bifurcate, but branch, forming a complex pericapsular and pericellular network. In other words, these processes do not extend beyond the bounds of the ganglia (Dogiel).

(*c*) Multipolar cells resembling those of the sympathetic system. Exactly the same relation exists in all of the mixed cranial nerves. The trifacial or fifth has its ganglion situated within the cranium. The cochlear and vestibular nerves have their ganglia in the internal ear. The former has its ganglion of Corti in the canal of Rosenthal; the second has its ganglion of Scarpa, at the entrance of the internal auditory meatus. The cells in these ganglia are bipolar in contrast to other ganglion cells.

The pneumogastric and glossopharyngeal have their ganglia extracranial, which is equivalent to extraspinal. They have, there-

fore, their efferent and afferent axones to and from the ganglia, and their trophic motor cell bodies are situated in a continuation of gray matter of anterior cornu in medulla and pons. They are, therefore, all essentially spinal nerves, except those of special sense, which should be called cerebral, and in future will be called cerebral nerves. The cranial nerves are from a surgical standpoint practically spinal nerves, governed by the same laws, having the same histology, anatomical relations, degenerative changes, and regenerative potency as spinal nerves.

The nerves of special sense, which we call cerebral, have an entirely different relation, as their ganglion or trophic cell bodies are situated in the periphery or special sense organs, and the axones extend from the periphery centripetally, passing inward to contact with the dendrites of special sense ganglionic cells; that is, the axone trophic cell bodies of the optic nerve are situated in the retina, the olfactory in the mucous membrane of the superior turbinated fossa, the gustatory in the taste corpuscles situated principally at the circumvallate papillæ of the tongue, and the auditory in the cochlear membrane (organ of Corti). Their axones extend to the brain and make up the nerve trunks of special sense. With the exception of the optic and some fibers of the auditory, they are neurilemmic and capable of regeneration. The optic and the aneurilemmic fibers of the auditory are incapable of regeneration. All of the axones terminate in the opposite side of the cord or brain from which they originate, except the axones of the direct cerebellar tract.

Ascending or descending degeneration means a degeneration upward or downward from the point of division only, and always in a direction opposite to the location of the trophic cell body. From the point of division, proximally toward the cell body, there is an atrophy, but not complete degeneration of the axone. In neurilemmic axones there is a degeneration to the first node of Ranvier and an atrophy proximal to that point, even including the cell body or ganglion cell. The scheme above given shows distinctly the direction of degeneration in spinal cord division, and of atrophy in contusion or compression. Still we deem it necessary to give a detailed description of it, which for emphasis will be considered in the opposite order to that of the tabulation:

Origin and Termination of the Axones of the Columns (Fasciculi) of White Substance of the Cord.

	Columns.	Fasciculus.	Trophic cells of origin.	Termination.	Degeneration.
1	Anterolateral columns.	1. Direct pyramidal (motor) same side.	Cerebral cortex.	Brush ends of motor cells of anterior cornu on opposite side.	Descending.
		2. Crossed pyramidal (motor) same side.	Cerebral cortex.	Brush ends of motor cells of anterior cornu of same side.	Descending.
		3. Direct cerebellar (fasciculus of equilibrium) same side.	Clarke's column	Cerebellar cortex of same side.	Ascending.
		4. Anterolateral (Gowers).	Gray substance of cord of both, same and opposite sides.	Partly in cord, partly in cerebral substance.	Ascending.
		5. Anterolateral. Ground bundle association (same side).	Gray substance of cord.	Spinal cord.	Limited degeneration. Ascending and descending.
2.	Posterior columns.	1. Cuneatus (Burdach). Sensory (same side).	(*a*) Spinal sensory ganglion (Exogen fibers) (*b*) Gray substance (endogen fibers).	Either gray substance of cord or in nucleus cuneatus, whence new fibers originate, cross and terminate partly in cerebellum, partly in cerebrum.	Ascending.
		2. Gracilis (Goll). Sensory (same side).	Spinal ganglion (exogen fibers).	do. do.	Ascending.[1]
		3. Lissauer.	Gray substance of cord. Spinal ganglion.	Either in posterior horn or in fasciculus cuneatus.	Ascending degeneration.

Posterior Columns; Fasciculus Gracilis (Goll) and Fasciculus Cuneatus (Burdach).

These contain fibers, some of them short, uniting the different levels of the cord; others long, which go from both uninterrupted to the medulla oblongata. The most internal come from the lowest segments of the cord; the most external from the highest. In the medulla oblongata, they terminate in brush-like endings in the nucleus gracilis (Goll) and nucleus cuneatus (Burdach), around the dendrites of cells situated in these nuclei. From these cells new fibers originate and go upward, some in the cerebellum, where they come in contact with central centripetal somesthetic axones; others in the cortex. The fibers originating from the cells of these nuclei cross soon after their origin in a similar manner to the motor fibers of the pyramidal tract. After crossing they join the deep surface of the pyramidal tract, and accompanying it go to the cerebral hemispheres. It can, therefore, be seen that a hemisection of the left half of the cord, for example, would produce a paralysis of sensation in all the structures on the same side below the division.

Zone of Lissauer or marginal zone of Lissauer is situated in the sulcus lateralis posterior, between the external angle of the posterior column and the internal angle of the lateral column. The fibers of the posterior roots passing through it divide it into two halves, one external, the other internal. In the lumbar region, the zone of Lissauer has its greatest dimensions. According to Lissauer, the zone is composed of the fine fibers of the posterior roots, while other embryologists consider it as being formed by the collaterales given off by the fibers of the posterior roots when penetrating the network. Testut thinks that it is composed of both root fibers, both ascending and descending, and their collaterales. The fibers in the zone of Lissauer enter usually after a short journey, some in the posterior horn, others in the fasciculus of Burdach.

The anterolateral ground bundles contain short fibers which unite the different levels of the cord. They do not go to the brain. Thus, degeneration is always limited, both ascending and descending.

The Ascending Anterolateral Column or Tract of Gowers.

The trophic cell bodies of this column are situated, according to Sherrington and Edinger, in the posterior horn close to the commissure. The axones originating from these cells mostly pass to the opposite side in a transverse manner until they have reached the periphery of the cord, then they change direction and become vertical in order to make up the column. In other words, the fibers of this column are crossed within the gray substance of the cord. The ascending fibers of the column reach the lateral surface of the medulla oblongata in the region of the inferior olivary body, where they partially or totally terminate in the nucleus of Bechterew, whence they approach the peduncular island of Reil, and from there go to the cortex cerebri.

The Direct Cerebellar Tract.

The axones of this tract originate from a group of cells situated at the posterointernal region of the posterior horn and close to the commissure, forming there a distinct column of Clarke. In the lumbar and cervical region where the column is not distinctly formed they originate from cells which are homologous to the column of Clarke. The uncrossed fibers of this tract terminate in the dorsal portion of the vermis superior of the cerebellum. Degeneration is therefore ascending, and on the same side with division. A hemisection of this column would involve the loss of automatic equilibrium on the same side as the lesion.

The crossed pyramidal tract contains axones originating from the pyramidal motor cells of the cortex; they descend in the bulb and after the crossing of all of its axones (decussation of pyramids), descend in the cord of the opposite side, so that fibers originating from the right half of the cortex are situated in the left half of the cord, and vice versa. Degeneration is, therefore, descending. In a hemisection in the cord, involving this tract, there is almost complete paralysis of muscles of the same side, the only remaining motion being supplied from the direct pyramidal tract from the opposite side. This remaining motion explains

some of the errors in the reports in cases of supposed regeneration of the cord after hemisection.

Direct Pyramidal Tract.

Its axones originate from the pyramidal cells of the cortex. They descend in the bulb and cord on the same side to a point in the white substance where they cross and pass to contact with lower motor neurones whose axones pass directly out of the cord through the anterior root. It ultimately must be considered a crossed tract, because its fibers cross at the level of entrance into the gray substance. Degeneration is, therefore, descending, and a division of this tract produces a partial paralysis or paresis of the opposite side.

TRACTS OF DEGENERATION OF SPINAL CORD AFTER DIVISION.

RECAPITULATION.

Six Sensory Fasciculi.

Tracts which undergo ascending degeneration.
1. Posterointernal fasciculus gracilis (Goll).
2. Posteroexternal fasciculus cuneatus (Burdach).
3. Cerebellar tract.
4. Zone of Lissauer.
5. Anterolateral tract or ascending tract of Gowers.
6. Column of Clarke.

Two Motor Fasciculi.

Tracts which undergo descending degeneration.
1. Crossed pyramidal tract. (It is the chief motor tract and contains 90 per cent. of the motor fibers.)
2. Direct pyramidal tract, fasciculus of Turck. (Contains only 10 per cent. of motor fibers; division of the direct pyramidal tract produces a diminution of the muscular tonus.)

Tracts which do not undergo either ascending or descending degeneration, or at least for no great distance.
- Anterolateral ground bundle.
- Short commissural tracts or association neurones.

MEDULLA OBLONGATA.

The medulla oblongata is nothing more than the intracranial portion of the spinal cord, or spreading out of the cord. Its lower

limit is a plane passing through the decussation of the pyramids, which corresponds to the foramen magnum; above, it is continued by the pons varolii, and is outlined from the same by the abrupt margin of the pons.

In its lower portion it perfectly resembles the spinal cord. We find the anterior, posterior, and lateral fissures, and the various columns delineated by them. A cross section in the lower part of the medulla shows all the elements of the spinal cord with their white and gray substance arranged in a similar manner as in the latter.

On the posterior surface of the bulb the posterior columns instead of ascending diverge so that they form a sharp angle; these are the lower angular limits of the fourth ventricle, its upper limits being formed by the superior cerebral peduncles.

A cross section of the upper third of the medulla presents an entirely new aspect. The organ is still divisible into two symmetric halves, but they are not separated any longer by the anterior median fissure. The posterior median fissure has also disappeared. The ependymal canal has enlarged in order to form the fourth ventricle. The gray substance of the bulb at this level has lost its H-shaped arrangement. Instead of this we find nuclei which are small masses of gray substance formed by the decapitation of the anterior lateral and posterior horns by the crossing of the motor and sensory fibers. In addition to the neuronic elements transmitted from the spinal cord and cortex we find the bulb elements proper which originate here.

Of the seven fasciculi of the spinal cord, three cross in the bulb; these are the crossed pyramidal tract, fasciculus cuneatus and gracilis; all the others are situated in the bulb on the same side as in the spinal cord.

A slight restriction must be made with regard to the direct pyramidal tract, which occupies the same side in the bulb and in the spinal cord, this, however, only to the level at which its axones enter the gray substance of the opposite side of the cord to contact with the lower motor neurones. The axones of the posterior columns terminate in the bulb in their respective nuclei (nucleus of Goll and Burdach), in end-like brushes around the cells of these nuclei. From the latter new fibers originate, which shortly after cross those

of the opposite side, and they ascend in order to form the fasciculus of Reil. It will, therefore, be seen that the medulla is a continuation of the cord and its tracts. Most of the cranial nerves originating here, from a surgical standpoint at least, are practically spinal nerves. We will speak of all these nerves, except those of special sense, as cranial nerves, while those of special sense will be classified as cerebral nerves, for the more positive anatomic and histological reasons given above.

ZONAL DEGENERATION AND REGENERATION OF SPINAL CORD.

(*a*) *Degeneration.*

In addition to the ascending and descending degeneration there is traumatic or zonal degeneration. Almost immediately after division, degenerative processes begin and are completed in a few weeks. At first the myelin sheaths swell, gradually break down and disintegrate; the axis cylinder is next involved; the gliæ tissue proliferates and replaces both cells and axones with connective tissue until the entire degenerative tissue is finally replaced by connective tissue. This zonal degeneration gives all the evidence of a complete destruction of the ganglionic cells of motion over that particular zone, and in its restricted peripheral zone there is an absence of reflex manifestation; while reflex phenomena remain intact above and below that point.

In cortical lesions, hemiplegia, for example, the degeneration extends through the entire axone of the upper motor neurone down to the motor ganglionic cells in the gray matter of the anterior horn of that particular segment, but there is no degeneration of motor cells in the anterior horn, nor of their axones in the peripheral motor nerve.

The following is a detailed description of degenerative processes as given by Schiefferdecker:

Shortly after section of the cord in dogs, there is "a traumatic degeneration," extending upward and downward for a distance of 6 mm. In the first few days after division there is an extravasation of blood, which later is absorbed. There are clefts in both white and gray substances containing shining plates, possibly derived

from the swelling of the axis cylinders; these are absorbed later. After fourteen days the ends of the cord are firmly united by connective tissue; later the line of division is barely discernible from the outside. There may be a slight retraction of the dura at the point of division. Schiefferdecker was unable to find, after 238 days, the slightest attempt at regeneration of axones at the point of division. We have, therefore, a perfect afunctional mechanic reunion.

Enderlen, studying the changes after punctured wounds of the cord of rabbits, mice, and dogs, found after two hours, swelling of the axis cylinder, followed by the appearance of fat droplets, and a progressive degeneration of ganglionic cells, leading on to fatty degeneration. On the second day there was a beginning proliferative process in which the gliæ connective tissue and vessels took part. In the ganglionic cells there was an increase of chromatine, but never a karyokinesis and division. On the fourth day vessels from the pia penetrated the injured region. The fat droplets diminished and newly formed glia cells appeared in great numbers between the eleventh and twelfth day. From the thirteenth day star and spider-like cells increased, forming a dense glial network in which there were still some degenerated nerve fibers and ganglionic cells.

Stroebe observed about the same changes at the beginning of the injury. After two days he saw a marked proliferation of connective tissue in the pia mater, leading to a formation of connective tissue, rich in cells and vessels, which contained many phagocytes. In the stumps of the divided cord there was a great proliferation of connective tissue.

(*b*) *Regeneration.*

In lower forms of life regeneration of cord was supposed to be possible, as demonstrated by the fact that after amputation of the tail of a lizard, not only the tail is reproduced, but also the spinal cord. This observation was made by Spallanzani. His findings on the reproduction of the cord in the lizard have been confirmed by many other experimenters, such as Müller, Colluci, Caproso, and Magini. This should not be construed to mean a regeneration of true cord, the caudal zone of the spinal cord of man regenerates,

but it is not true cord, as the cauda is composed of axones with a neurilemma which originate from the spinal ganglionic cells in the anterior cornu of the true cord. Even in lizards there is no record of regeneration higher up than the conus of the cord, which supports the position we take *that regeneration of cord proper, that is, above the cauda, has never been observed and will not take place.*

Regeneration of the cord in the tail region of Lacerta viridis is less complete than in that of Triton. Some doubt the regeneration of nerve cells in the former.

Sgobbo Francesco has observed in the lizard regeneration of the cord in the dorsal region after division. The degeneration which apparently originated in the epithelium of the ependyma was not so marked in the cicatrix of the dorsal region of the tail. These remarks evidently refer to histological appearance and not to function, which is the point that concerns us as surgeons.

Masius and Vanlair removed one to two centimeters of cord in frogs, and after a few months found that the absent portion was replaced by a yellow gelatinous mass, which they considered to be composed of ganglion cells and Remak's fibers. It is stated that there was also restoration of function. This is inserted as a direct contradiction to the results of so many other experimenters, but it is explained by the fact that the portion of the cord removed from the frog must have been the "caudal zone," and this zone in man has also the power of regeneration, as it is made up of neurilemmic axones. From our personal examination of the spinal cord of frogs we can say that the caudal zone extends very high up, almost to the lower angle of the scapula, therefore, a division of the spinal cord a little below the middle of the body does not mean a division of the true cord; this will only involve the caudal zone and not the true cord.

In spite of these observations on the frog Sgobbo Francesco was unable to notice any karyokinesis or other evidence of nerve regeneration at the point of transverse section of the cord.

Voit, Duval, and others support the theory of regeneration of neurones. They observe, in cases of removal of the brain in pigeons, that a mass similar to brain substance appeared in the skull after a certain length of time. This, however, must not be interpreted as a physiological genetic material.

Brown-Sequard found that after complete transverse division of the cord in pigeons there was apparent restoration of function. The ends of the cord were physically united and in the cicatrix ganglion cells and nerve fibers developed. This, we believe, was only an apparent restoration, as the movements proved to be only reflex, exactly what they should be and are after division of the cord in man, and is an evidence rather against than in favor of regeneration. His experiments were contradicted by Picolo, Santa Selina, and Francesco.

Regeneration of nerve cells in dogs has been described by Denton, Masius, Baer, Dawson, and Marshall. Eichhorst and Naunyn have described penetration of the cicatrix by nerve fibers "without regeneration of nerve cells." Westphal and Schiefferdecker deny these findings.

Experiments on dogs by Denton, Marinesco, Sgobbo Francesco, Eichhorst and Schiefferdecker, may be summarized as follows:

(*a*) Transverse hemisection of the cord was sometimes followed by restoration of function without the appearance of new fibers in the cicatrix. *The function was due to the impulse travelling along the fibers in the uninjured half of the cord.* This would explain, we believe, the erroneous statements in the reports of clinical cases, as the direct pyramidal tract is not interfered with in hemisection and it supplies about 10 per cent. of motion below the line of division on the divided side.

(*b*) Complete transverse section of the cord was followed by apparent limited restoration of function. The cicatrix showed nerve fibers, although there was no evidence to prove that the cut fibers were united end-to-end. (Eichhorst.) These experiments, however, show that apparent restoration was none other than reflex action and if Masius and Vanlair had demonstrated that reflex action existed after exsection of the frog's cord, and between that and the time of supposed restoration, then we would have proved positively that the excised portion was not the caudal cord, but true cord, as the cauda has no ganglion cells for reflex action. This, however, was not done.

Contrary to these findings, Schiefferdecker, Francesco, Piccolo, Santi, and Serena did not find, after transverse section of the cord, either restoration of function or regeneration of new fibers in the

cicatrix. These and many other experiments prove that the cord of the superior vertebrates, which includes man, is not capable of regeneration after its division or destruction.

Stroebe, however, observed regeneration in the posterior root, the axones advancing from the spinal ganglia to the cord, and even penetrating the connective tissue scar of the cord. Furthermore, Stroebe saw at the seat of the degeneration of the cord new fine axones endeavoring to penetrate the scar. He mentions the fact without saying definitely that these fibers were newly formed neuronal substance. Even if this be the case, he thinks the connective tissue interferes with the transmission of impulses, so that his results may have been histologically positive but functionally were negative.

Marinesco, who once was among those who denied the possibility of histological regeneration of axones at the seat of degeneration after division of cord, in a recent article published in one of the April numbers of *La Semaine Medicale*, confesses that his previous statements were erroneous. He has made some very beautiful and instructive observations on the regeneration of nerve roots and spinal cord. He showed that the reason why he and the others did not find any regenerated axones at the seat of division was due to the improper staining methods. He states that the stains previously used had no affinity whatsoever for the axis cylinder. By using the special stain for axis cylinders of Ramon Y. Cajal he found that there was an effort at regeneration of the spinal cord axones from the ganglionic side and that these embryonic axones penetrated for a short distance into the new connective tissue, and then ceased. He concludes that it is this new cicatricial tissue that prevents the advancement of the axones. This, we believe, is erroneous. Practically all cells make an effort at reproduction from the nuclear or trophic remnants, but they only span very limited distances. In spinal axone regeneration the new axone from the proximal side must not only penetrate the new glial connective tissue but the entire degenerated axones. There are no new embryonic axones in the spinal tracts, as the spinal axones have no neurilemma to produce them, differing from the peripheral nerves in this vital particular.

According to Ludwig, Tirelli, and others, karyokinesis is not

possible in the spinal nerve cells of higher vertebrates after the stage of development at which the dorsal white columns are sufficiently formed to produce a distinct median fissure in the cord.

In the human subject, regeneration of the degenerated fibers of the cord has not as yet been demonstrated so far as function is concerned. The nerve roots outside the cord, however, regenerate in the same way as the peripheric nerves. Weissman's dictum can be properly inserted here: "Ganglionic nerve cells once destroyed in the gray matter of the cord are never reproduced or replaced." We may add that ganglionic cell bodies and aneurilemmic axones are never functionally reproduced. This includes all ganglionic cells, the axones of nerves of special sense and the axones of the white column of the cord.

Lewellys F. Barker says: "Regeneration of severed nerve fibesr within the spinal cord and brain is unfortunately very much less complete than in the peripheral nerves." (*The Nervous System*, p. 246.)

DEGENERATION AND REGENERATION OF MOTOR AND SENSORY ROOTS.

Anterior Root.

The division of an anterior root is followed by degeneration of the entire peripheral segment and a small portion of the distal segment, generally not extending beyond the first node of Ranvier. The trophic ganglionic cells of the respective fibers are situated in the gray matter of the anterior horn. They suffer more or less great changes, according to some authorities (Van Gehuchten and Nelis). Others, however, believe that "chromolysis" takes place after the division of a cranial nerve only, while after division of a spinal nerve there is no chromolysis of the ganglionic cells of the spinal cord.

Whether partisans of "Peripheral" or "Central" school, all authorities agree that if the ends of a divided motor root are united, restoration of function takes place. This is in strict accordance with the histology and minute anatomy; the axones of the motor nerves are neurilemmic from the time they leave the cord, and should, therefore, regenerate completely if accurate aseptic apposition is made.

All these statements refer to fibers of the motor roots outside the cord, that is, after they leave the lateral fissure. If, however, the motor fibers are divided within the spinal cord, then *restoration never takes place.*

Posterior Root.

If a posterior root is divided between a spinal ganglion and spinal cord, the fibers degenerate proximally or cordward from the line of section. In the cord there is a degeneration at the level of division. Below this level there are few degenerated fibers in the so-called comma tract. Above the level there is a degeneration in the external portion of the Burdach column, while higher up the degeneration takes place in the internal portion of Burdach's column and the external portion of Goll. Still higher, the degenerated fibers are confined exclusively to the fasciculus gracilis, whereas, the cuneatus is free from degeneration. These upper axones which do not degenerate are association axones, and axones from higher ganglionic cells, as seen from our analysis of the anatomy of the posterior columns, and should not degenerate as they are not separated from their respective trophic cell bodies.

William G. Spiller and Charles H. Frazier performed some experiments in the regeneration of spinal roots. Their results point to the conclusion that after section of the cord the intermedullary roots were permanently degenerated, as no newly formed fibers could be found. No regeneration took place within ten months, and the authors say, "We may assume that it would not have occurred had this dog lived much longer."

Stroebe, after injuring the spinal cord and some of the roots, observed a few fibers penetrating the scar tissue of the spinal cord. Biekles noted similar phenomena in man, but remarked that the penetration was very imperfect. His observations corresponded with those of Kahler, in that the extramedullary roots are capable of regeneration, while the intermedullary ones, regardless of favorable conditions, are not capable of restoration. The maximum regenerative potency of the axone is limited to a very short distance, probably the length of a dendrite; this has never been experimentally demonstrated, but from the anatomy and from the func-

tional restoration of peripheral nerves, as well as the observations made by Biekles on the divided end of the spinal cord, seems plausible. The potency of regeneration is controlled or governed by the regenerative energy which the axone receives from the ganglionic cell body and is analogous to the limited distances spanned in regeneration of bone, muscle, tendon, etc. There is no more striking illustration of the relation between the size of the ganglion and nerve regenerative potency than that furnished us in both the clinical and experimental observations on the trifacial. The axones of the Gasserian ganglion, the largest ganglion in the body, will penetrate an enormous amount of connective tissue, and even circumscribe foreign bodies in their efforts to reunite with the peripheral sensory bulbs; these observations explain the frequency of recurrences of trifacial neuralgias after nerve division, root resection, and chemical neurosis. The period of time for reapproximation or re-establishment of the axone is expressed in the period of relief obtained after the operation.

HISTORICAL DATA CONCERNING SURGERY OF THE SPINAL CORD.

Paulus Ægineta, in the seventh century, was the first to advise operation for fractures of the spine, but it was not until the eighteenth century, when Heister recommended operative treatment, that the subject received serious attention.

The latter recommended extraction of the fragments in cases of fracture, where the depressed fragments compressed the cord.

The first operation for fracture of the spine was performed by Louis, in 1762, but the first attempt worthy of consideration was made by Cline, in 1814.

In 1820 the subject was extensively discussed before the Medico-Chirurgical Society. In 1823 Sir Astley Cooper wrote: "If you could save one life in ten, one in a hundred, by such an operation, it is your duty to attempt, and he who says it should not be attempted is a blockhead."

In the beginning of the nineteenth century a very earnest debate was carried on between Sir Astley Cooper and Charles Bell, the former a great advocate of surgical intervention, and the latter

opposed to it. Brown-Sequard was at first opposed to operation, but later advocated it.

Leyden in his clinic on spinal cord diseases advised operation in case of fracture of the arch of the vertebræ, and, since the successful operation of Macewen, laminectomy has been performed many times. In 1887, Horsley and Gowers first successfully removed a subdural tumor. In 1899, Chipault reported 167 operations for spinal fracture from his personal experience.

SURGERY OF THE SPINAL CORD.

Surgical intervention in spinal cord affections has been at all times a matter of hesitation on the part of surgeons. Results were so varied and indefinite that for a long time no conclusions could be drawn as to the advisability and probable outcome of operative treatment. Statistics were meagre and their reliability doubted where favorable results were recorded.

In this paper we do not intend to consider in detail the entire field of surgery of the spinal cord, or to offer anything particularly new. We will deal mainly with the different types of injuries to the spine and spinal cord, and endeavor to bring out the important points in diagnosis and definite indications for surgical treatment in cases amenable to it. We also hope to be able to show that certain cases should not be operated, as they are absolutely hopeless from our histological knowledge of spinal cord degeneration. The chapters to be covered are:

(*a*) Contusion.
(*b*) Concussion.
(*c*) Punctured wounds of the cord.
(*d*) Hemorrhage or clot in spinal canal and cord.
(*e*) Dislocations and fractures.
    1. Contusion of the cord.
    2. Compression without division.
    3. Partial division of the cord.
    4. Total division of the cord.
(*f*) Gunshot wounds.
(*g*) Tuberculosis of the spine and spinal cord.
(*h*) Tumors.
(*i*) Spina bifida.

Contusions. Contusions of the spine may be of various degrees. They may affect the superficial tissues, as the muscles and ligaments, cause an effusion of blood into the spinal canal or cord, or cause traumatic zonal inflammation *with paralysis without division* of the axones. The symptoms following a contusion to the spine may be widely at variance with the apparent degree of trauma, and a classic clinical picture would be impossible. In many of the cases of contusion to the spine, even in those of a severe character, we may be surprised to find no symptoms of cord injury at the beginning. I have had several cases under my personal observation in which no initial symptoms were present, but in which in a short time, varying from a few days to several weeks, a traumatic reaction set in, and the patient developed complete paraplegia of both motion and sensation.

The following cases will illustrate this statement: On January 20, 1891, a patient, Mr. A. M., aged twenty-three years, while carrying a carboy of acid across a bridge, fell a distance of twelve feet and struck on his buttocks. He felt some pain after the fall, but was able to resume his work in a few hours. For three days following the injury he was able to walk and work. On the fourth day pain in his back obliged him to discontinue work. From that time on weakness and inco-ordination of the limbs gradually developed, although he was able to walk with the assistance of crutches until February 10. At this time upon examination I found that the spine was sensitive to pressure at the eleventh lumbar vertebra, but no fracture could be detected. There was no numbness of the limbs but inco-ordination of motion. February 27 his paralysis was complete below the level of the dorso-lumbar junction, incontinence of feces and retention of urine. This continued for three months. At the end of this time sensation began to return. There was partial restoration of motion at the end of four months. In June of the same year, patient was again able to walk with the assistance of crutches, and finally at the end of fourteen months motion and sensation were completely restored. This case illustrates two points, first, the absence of initial evidence of injury to the cord and development of paralysis five weeks later; second, complete restoration of function without surgical intervention after fourteen months.

In such cases, while there is no gross anatomical change in the spinal cord and its membranes, we are convinced that some changes must have taken place later in its vessels and neuroglia which interrupted the transmission of impulses. Cases of this type have been clinically interpreted as destruction of spinal cord with regeneration. They do not deserve such interpretation. They are simply zonal paralyses which are produced without division of the cord or axones and are completely restored after the inflammatory condition has subsided and the products of the inflammation have been removed. There is no regeneration of spinal axones. The observation of Schmauss, namely, edema and swelling of the ganglionic cells and of axones in the traumatized cord of rabbits does not necessarily mean degeneration; we interpret it as an atrophy, as shown by the frequent recoveries in similar cases in man. These have proven the truth of this assumption. Several observers have noted cellular changes in the gray matter and neuroglia of the cord after applying great force to the spinal column, insufficient, however, to produce fracture or dislocation. Following laminectomies we frequently have complete paraplegia with full restoration of function, illustrating operative zonal inflammatory reaction.

An insignificant trauma to the spine may cause marked paralysis. August 18, 1886, I had under my care a patient, Mr. K., who, while sitting in a hammock, tipped backward a distance of two feet to the ground. Immediately after the accident he developed a paralysis of motion and a numbness of sensation in both the upper and lower extremities. There was no special deformity or displacement, but great sensitiveness at the fifth cervical spinous process. In November, of the same year, the patient was able to walk, though hesitatingly, and had still a numbness of sensation in the previously paralyzed members. In May, 1887, he was still coming to my office. At the same time he was practically well, except for some unsteadiness of gait and uncertainty of equilibrium when he turned suddenly. The index and middle fingers of the right hand were the last to recover. This is a good illustration of the traumatic transient type of zonal paralysis.

Concussions. By spinal concussion is meant an impairment or loss of function of spinal cord due to injury which is not suffi-

cient to produce gross anatomic changes. The term "spinal concussion" is admitted by some surgeons and rejected by others. While we admit spinal concussion as a temporary reaction on the part of the cord, we do not consider it as a definite morbid entity. But we do not accept as spinal concussion other cases than those with symptoms of pronounced zonal hyperesthesia or anesthesia and with a zone of diminished reflex or paralysis partial or complete. Those who deny spinal concussion base their views on anatomical grounds, namely, the small size of the cord, as compared with the spinal canal, and its suspension in the canal by the denticulate ligaments and nerve roots which protect it from injury in traumas short of fracture or dislocation. In this connection we must mention that hemorrhage in the spinal canal may produce an exact clinical picture of spinal concussion. Therefore, differential diagnosis between these two conditions is quite impossible. There are several cases on record, however, where the disappearance of paralytic symptoms, in a short time, point to the probability of spinal concussion. On the other hand, many postmortem examinations have not shown any anatomical changes in cases where marked paralysis following injury were noticed and continued up to the time of death. The following classical case is recorded in Guy's Hospital Reports:

A woman fifty-nine years of age fell on her back and immediately developed marked paralysis of the upper and lower extremities. On the tenth day she died of pneumonia. A careful postmortem examination was made and no anatomical changes were found either in the brain or cord. There was no evidence of effusion of blood in the spinal cord or canal.

We have had in our experience several cases of injury to the spine in which physical examination did not reveal evidence of dislocation or fracture, although the patients developed marked paralytic symptoms. In all of these cases perfect recovery took place in from six to twenty months.

Punctured Wounds of the Cord. The knife is usually responsible for such wounds. The cord may be injured without fracture of the vertebræ. Wagner-Stolper has collected 86 cases of punctured wounds of the cord. Of these, more than half occupied the cervical portion and the remainder the upper region

of the dorsal. There was no case of puncture of the lumbar cord. The reason for the cord being punctured more often in the upper part is very simple. The object of an assailant is generally the head, and anatomically there is a considerable interspace between the vertebræ in this region for the admission of the knife blade. As a rule such wounds involve one-half the cord, though sometimes the knife may pass beyond the median line and injure the other side. The clinical picture of punctured wounds of the cord is that of a hemisection lesion. Out of Wagner-Stolper's 86 cases, 44 presented this picture of hemisection.

The symptoms appeared immediately after the injury and the course was generally an aseptic one. Twenty per cent. of the cases mentioned by the above author died. The rest of the cases improved, but few recovered. So far as treatment is concerned, very little can be done beyond rendering the external wound aseptic and keeping it so. Operation is never indicated except where infection of the spinal canal has occurred, or when there is compression from hemorrhage. If this is manifested early it can be relieved by a lumbar puncture with a large needle. The divided axones of the cord do not regenerate as they have no neurilemma, and suture of the severed segments is not only useless but adds to the danger. Such paralysis as results from effusion or traumatic zonal inflammation will subside without operation. Therefore, these cases all contraindicate laminectomy.

HEMORRHAGE; EFFUSION OF BLOOD IN THE DURA AND SPINAL CORD.

The blood may occupy the spinal canal, extradural; may be beneath the meninges; or may be in the substance of the cord itself. In the second case it is called hematorachis; in the third, hematomyelia. The most important etiological factor of hematorachis and hematomyelia is trauma from a blow, fall, gunshot, or stab wound of the spinal canal. The symptomatology of hematorachis is not definite. Patients usually complain of pain in the spine, paroxysmal and burning in character, along the nerves, and occasionally muscular spasms, opisthotonos, convulsions, and finally paraplegia. While the paraplegia is sudden and complete in fractures and lesser injuries to the spine, in hematorachis it is

gradual and progressive, often developing two to four days after the injury. The above-mentioned symptoms of hematorachis usually develop in the first twenty-four hours, increase in severity up to the fourth day, and disappear in from four to six weeks. There are, however, cases in which the paraplegia is sudden and complete, depending upon the size of the vessel, as in a case of mine of bullet wound of the cervical region and one of Edward Janeway.

The best test for hemorrhage (in fractures, bullet wounds, etc.) is spinal puncture; 20 to 30 c.c. of fluid may be drawn off. If the cord is injured above the spinal puncture then the spinal fluid may be bloody.

The hemorrhage may be extradural or intradural, or combined. When the dura is lacerated, hemorrhage is usually due to rupture of the venous plexus, and rarely to rupture of arteries. The blood has a tendency to extend downward, and, therefore, the hemorrhage is more extensive if the lesion is situated high up. As the lumen of the spinal canal is large, the quantity of blood is considerable. Diagnosis of intradural hemorrhage can readily be made by lumbar puncture, and the pressure of the cord relieved by this procedure if the puncture is made early.

While hemorrhage is generally due to injury, occasionally it may be non-traumatic in origin. Edward Janeway, for example, reports a case of spontaneous subarachnoid hemorrhage in a bleeder. The young man, after having recovered from a slight attack of influenza, suddenly lost sensation and motion in the lower extremities and fell to the floor. The autopsy revealed extensive hemorrhage in the subarachnoid space up to the middle cervical region; there was also some blood between the dura and the arachnoid. Patient's brother was also a bleeder.

Hemorrhage into the spinal canal may produce marked paralytic symptoms, even to complete paraplegia. In such cases diagnosis cannot easily be established, as illustrated by the following case from my practice in Cook County Hospital, in 1887:

A man was shot in the neck. The bullet passed externally to the jugular vein just above the clavicle. He said he did not fall immediately after this wound. A second bullet passed through the shoulder and hand, when he fell to the floor. He was taken to

the hospital shortly after the accident. There was complete paralysis of the upper and lower extremities. He was able to move the muscles of the neck only. The diaphragm acted on both sides. It was concluded that the patient's statement was wrong, and in all probability the first bullet entered the shoulder and hand, while the second one struck and divided the cervical region of the cord. He died on the third day. A postmortem showed that the cord was not injured by the bullet. The meninges were divided and the vertebral artery was severed, which permitted an extensive hemorrhage within the dura; this was filled with blood from the occiput to the cauda. In all probability the man's life could have been saved if the tension had been relieved by immediate tapping of the spinal canal in the lumbar region. From the postmortem findings it was evident that the first bullet entered the neck, as was stated by the patient, and the second the shoulder and hand, and that his fall was due to the blood pressure on the spinal cord from the hemorrhage in the canal.

Hematomyelia. Hemorrhage into the substance of the cord usually occurs in the region of the fourth, fifth, and sixth cervical vertebræ. According to Thorburn the hemorrhage in that region is due to over-flexion of the spine. If the hemorrhage is confined to the gray substance only, there is wasting of muscle and anesthesia of the upper limbs; also zonal absence of reflex. If the hemorrhage involves the white substance, we have paraplegia below the level of the lesion. Prognosis must be guarded in cases of hematomyelia. Even in cases of recovery there is always a weakness left, due to the destruction of the ganglion cells of the motor neurone at the point of hemorrhage. Hematomyelia may be due to gliosis spinalis. A patient of von Bergmann, a girl, aged nineteen years, died from this condition as shown by the postmortem examination.

DISLOCATIONS AND FRACTURES.

Dislocations. A dislocation without fracture practically never occurs. Rarely we find luxation alone of the upper cervical segment, but as a rule dislocation is associated with fractures and the symptoms are then those of compression. Recovery is possible if the cord is not divided and the compression is relieved early.

The subject will, therefore, be treated under the head of fractures, and included with them will be associated luxations.

Fractures. Fractures may be due to direct or indirect causes, as, for instance, forced flexion. The direct force may fracture a vertebra, but as a rule the fragments are not displaced. The laminæ and spinous processes may be driven into the spinal canal and cut off and compress the cord. This, however, is a rare type of accident and readily diagnosed. The bony fragments do not compress or lacerate the cord, at least primarily. The following history is a striking illustration of the exception to this rule.

Tony Y., aged thirty-eight years, Italian, laborer. Admitted to Presbyterian Hospital, May 3, 1906; died May 7, 1906. April 27, while attempting to get off a moving train, he fell or was thrown and was unconscious for fifteen minutes. On regaining consciousness he was unable to move the lower extremities, and complained of severe pain in the back. Has had retention of urine since that time, and it has been necessary to catheterize him. Patient does not know how he fell at the time of accident.

Physical Examination. Man, a laborer of fair muscular development. Head, neck, and chest negative, except congestion of the lower lobes. Abdomen negative; back, marked hematoma over lower lumbar region. Vertebral column shows a pronounced angle at level of third lumbar; the lower fragment is displaced forward for about an inch and a half. A superficial abrasion is present at this point. The displacement cannot be reduced by manipulation or extension.

Extremities. Left foot shows a hematoma on internal aspect of heel. There is a complete paralysis of sensation and motion below the second lumbar zone.

Reflexes. Abdominal, present; cremasteric, abolished; patellar, absent; Babinski, absent.

Diagnosis. Fracture of spine with anterior displacement of the lower segment; division of the caudal fasciculi.

Operation, May 3, 1906. Exposure of fractured zone by single incision. It was found that the arch of the second lumbar vertebra was driven in and compressed the cauda. The third and remaining vertebræ below were displaced forward; the arches of the third and fourth and the body of the third were fractured and the spinous

processes driven down on the cord. Almost all of the caudal filaments were divided by the great displacement forward of the lower segment. The second, third, and fourth spinous processes and laminæ were entirely removed; the dura opened for a considerable distance by a longitudinal incision and the fasciculi picked up, and the divided filaments united by end-to-end suture. The right and left halves of the proximal ends were easily determined by their position. The distal ends were considerably entangled but the right and left could be differentiated by applying the faradic excitor to the filaments. This brought a muscular contraction in its respective muscles notwithstanding that four whole days had elapsed since the division; when applied proximal to the contusion there was no muscular response. This muscular response after division corresponds to that obtained in our examinations of divided peripheral nerves the same length of time after their separation. After completing the approximations the dura was sutured in position, and a muscle flap drawn from each side filling the gap to the skin level. The patient withstood the operation fairly well, although his breathing was noticeably more rapid than at the beginning. From these physical findings we conclude that the man was struck in the back with great force, which first fractured the spinous processes and laminæ of three of the vertebræ and then carried the lower segment forward for a full inch.

May 4, the day following the operation, the patient was restless throughout the night and his respiration increased to 56. His pulse ranged from 118 to 132; temperature 101.6°.

May 5, patient delirous; had rather a restless night; respiration 64; some hypostatic consolidation of both lower lobes with râles extending up to the spines of the scapulæ behind; temperature 102.4°; pulse 124 to 140; urinary incontinence; bladder quite distended. From this time on patient's pulmonary manifestations were more and more pronounced. Temperature rose to 104.6°. He died on the morning of the seventh, apparently from a double pneumonia. No postmortem.

Indirect force may produce fracture and displace the fragments of the vertebra so as to either compress or divide the cord, as falls on the buttocks or shoulders or extreme flexions or extensions of the body. In these cases the site of fracture is usually at the

dorso-lumbar junction. Where the paralysis is immediate, uniformly transverse and complete of motion and sensation, there is no hope of recovery with or without operation, as the spinal cord is divided. Surgical intervention is of value only in cases where the fragments press upon the cord without having caused complete division. None of our cases (and there were many operated in our twenty years' service in the Cook County and Alexian Brothers' Hospitals) in which the cord was divided by a fragment, recovered. The degree of pressure on the spinal cord cannot easily be determined, and it is difficult to tell at the beginning how much pressure is being exerted on the intact cord. One can fairly accurately estimate when the cord is completely divided, as then there is a *complete immediate annular paralysis of both motion and sensation* below the line of fracture, which cases are beyond repair.

Fracture with contusion of the cord may give a motor or sensory paralysis below the line of union. The paralysis is rarely immediate, and is never complete and annular of both motion and sensation. The irregularities indicate that some columns of the cord are still intact; usually this paralysis comes on hours, days, or weeks after the trauma. It is preceded by a zone of pronounced hyperesthesia and is accompanied by abolished reflexes in this zone. The motor or sensory manifestations will predominate, depending upon whether the anterior or posterior columns of the cord have suffered most. Compression may be associated with contusion. There is no known means of making differential diagnosis of continued compression in addition to contusion, the degree of displacement of spinous processes being the only physical manifestation which we have for suspecting compression in addition to contusion. Both may have the same degree of primary paralysis; both may have the same speedy or slow increase in the paralysis; both may have a stationary degree of paralysis for a considerable period of time; both may have a late manifestation of paralysis, as shown in the cases cited under contusions. Therefore, differential diagnosis is impossible without laminectomy, which, however, is a procedure to be avoided, as a contused cord suffers additional insult by every operation, no matter how delicately performed. However, where compression is suspected on account of the great displacement, one must not hesitate, but operate immediately.

Partial divisions of the cord give a symptom complex resembling contusion, in that there is an irregularity in the transverse line of paralysis, and either sensation or motion may be present to a limited degree. Operation is contraindicated except where there is suspected continuous compression.

Walton says: "We have no symptoms from which we can assert from the outset that the cord is crushed beyond at least a certain degree of repair. It has been said that where there is complete loss of sensation, motion, and patellar reflexes, the cord is completely crushed, and consequently recovery cannot be expected." It is stated in the same article, that the patellar reflexes may be present in a case of complete transverse destruction of a segment of the cord. This is possible, as the ganglionic cells of the motor neurone below the point of division may be in perfect condition, though their contact axones of the central neurones are divided.

In fractures, with division of the true cord, operation with suture of the cord is absolutely worthless, as we have shown above that functional regeneration of the columns or gray matter never takes place. The improvements recorded by many authors were in cases in which only contusion of hemorrhagic compression of the cord existed, or where the type of traumatic zonal paralysis was present, which would have improved as well, if not better, without operation. Laminectomy in the dorsal and cervical region is, therefore, never indicated for division of the cord.

When the fracture occurs in or below the twelfth dorsal the treatment and prognosis are entirely altered. The cauda equina, which begins here, is made up of essentially peripheral nerve fasciculi, and not of spinal cord fasciculi, as the axones of the motor root in this portion have their ganglion trophic cells above this level in the conus, and the motor axones in the cauda are covered with the sheath of Schwann, or neurilemma. They, therefore, degenerate after division and have the power of regenerating the same as peripheral motor axones. The sensory neurones of the posterior roots of the cauda have their ganglion cells just inside the sacral and lumbar foraminæ. Their proximal axones, which run through the cauda to the spinal cord, are medullated and have a sheath of Schwann. They are capable of regeneration, at least

up to the posterior commissures, and from clinical observation we believe can again functionally contact with the posterior horn of gray matter. In other words, both the motor and sensory neurones in the cauda outside of the cord are histologically capable of regeneration under favorable conditions, that is, after accurate suture and exact approximation of the ends of the divided caudal fasciculi under aseptic conditions. It, therefore, becomes imperative for us to establish this approximation in every case of fracture of the lumbar spine with division of the caudal fasciculi and paraplegia. It is easy to determine which are the right and left fasciculi by a mild faradic current up to the seventh day after the injury. If the faradic current be applied to the individual nerve bundles *distal* to the trauma up to seven days after division there is a muscular response in the zone supplied by that bundle, as shown in case Tony Y. (just quoted). If it be applied, as will be seen in the above reported case of caudal suture, *proximal* to line of division, or even severe contusion, there is no electrical response. This corresponds exactly with the electrical response after division of peripheral spinal nerves external to the bony canal. Laminectomy with suture in this position is not extremely difficult. It has in it, however, the danger of sepsis, as the spinal canal and dura are open.

In every case of fracture, stab or bullet wound, where the cauda has been supposedly divided, exposure and suture of the fasciculi are positively indicated, the individual points of suture to be surrounded by egg membrane to lessen connective tissue interposition.

The transposition of caudal fibers in the treatment of unilateral paralysis of the entire lower extremity will be described under the article on peripheral nerve surgery, under its subdivision, nerve anatomosis in anterior poliomyelitis.

GUNSHOT WOUNDS.

Theodore Prewitt collected 49 cases of gunshot injuries treated since the antiseptic era. Operated: Recovery 11; dead 13. Non-operated: Recovery 8; dead 17. Mortality: Cervical region

55 per cent.; dorsal region 66 per cent.; lumbar region 0 per cent. Three cases of the latter operated. All recovered.

Conclusions of Prewitt:

(*a*) Immediate operation if wound is in accessible region, and if it involves posterior or lateral portions of the spine.

(*b*) It is imprudent sometimes to wait for repair to be effected by nature.

In bullet wounds of the spine, involving the spinal cord itself, operation is contraindicated, as from our knowledge of the absence of regeneration of the spinal cord proper, operation would be useless. If the cord is not severed, such fibers as are not divided will recover from the zonal paralysis resulting from the contusion and concussion without operation, while the fibers which are divided cannot derive any benefit from surgical procedure. If the bullet remains within the spinal canal and compresses the cord, as the skiagrams will readily show, it should be removed. If the cord is compressed by fragments of bone, which may also be determined by the radiograph, operation is indicated. If the cord be compressed by accumulated blood within the meninges, a lumbar puncture for its relief is indicated. The blood is kept fluid by its intermixture with the cerebrospinal fluid.

The following interesting case is reported by Richard H. Harte and Francis T. Stewart, *Philadelphia Medical Journal*, June 7, 1902. "Woman, aged twenty-six years, was shot twice with a .32 caliber revolver; operated by Stewart. One ball was lodged just beneath the skin; the other entered about an inch to the right of the seventh dorsal spine and traversed the spinal canal. Sequence: Paralysis of both motion and sensation below the level of a line drawn from the tenth spinous process to a point three and one-quarter inches above the umbilicus. The zone of hyperesthesia manifest just above the line of anesthesia. Temperature 97.6°; pulse 120; mind clear. Operation three hours after accident. Seventh and eighth dorsal spinous processes and laminæ were removed and bullet extracted from body of vertebra. Removal of bone fragments and contused cord débris; this left a gap between the segments of cord of three-quarters of an inch. Wound flushed with salt solution and ends of cord approximated with three chromicized catgut sutures, inserted by a small staphylor-

rhaphy needle. One was inserted anteroposteriorly and the others transversely. It was impossible to approximate the edges of the lacerated dura. A gauze drain was inserted and retained twenty-four hours. Patient withstood the operation very well; she was in better condition immediately after than preceding the operation.

On the fifth day there was evidence of sensation in the lower extremities. Superficial reflexes returned on the fifth day, and the patellar reflex was manifest on the twenty-first day. There was at the end of sixteen months voluntary flexure of toes, flexion and extension of legs and thighs, and also rotation of the legs. While sitting patient could extend the leg so as to raise it from the floor. Patient able to slide in chair. Bowels moved every other day; perfect control. One pint of urine was evacuated at each of three urinations in twenty-four hours. There was occasional incontinence of urine during sleep. Patient's temperature remained below 100° except on the fifth day, when it reached 101°. From the rapid return of sensation it is evident that some fasciculi of the cord were not divided, and from the return of motion even at the end of sixteen months there is still more forceful support of the same idea. The primary complete paraplegia was typical of traumatic zonal paralysis without complete division of the cord, with the possible exception of the speedy return of sensation. What portion of the cord was cut is difficult to say from the report given, but it is evident that it was not completely divided. These authors advise myelorrhaphy in transverse division of the cord, and state that it is especially indicated in cases in which the cord has been cut by a sharp instrument or severed by a projectile.

W. L. Estes, of South Bethlehem, Pa., in 1902 reported a similar case in which there were positive signs of some regeneration.

From our knowledge of the histology and from our clinical experience we feel certain that the restoration of function was misinterpreted as a restoration of regeneration. The former is a uniform result from impaired functions in contused, inflamed spinal axones, while the latter, regeneration of the spinal axones, never takes place.

In the case of W. Braun (*Berlin. Verh. der Deut. Gesellschaft f. Chir.*, 1906, p. 56) we have a striking illustration. A bullet, 5 mm. in diameter, was embedded in the centre of the spinal cord at the sixth dorsal body without dividing many of the spinal cord fasciculi, as is shown by the sequence of events. Three weeks after the removal of the bullet, which operation was performed thirty-seven days after the accident, there was return of function in the bladder and rectal control. Paralysis of motion and sensation were complete shortly after the accident, also the reflex action below the seventh dorsal segment. Twenty-three months after the operation, when the case was demonstrated, the patient was able to walk quite a distance with the assistance of a supporting apparatus and was able to ascend and descend low steps. These restorations must not be construed, however, as regeneration of spinal axones, they are merely the return of function in axones, where conductivity was impaired by the trauma and the traumatic inflammation, as shown by the speed with which function returned, which would have been impossible in regeneration.

Mortality. The causes of mortality from fractures of the cervical region are due to interference with the essential function of the centres of the spinal cord. Death may occur on the third or fourth day as the result of the degree of fracture. In fractures in the neighborhood of the fourth and fifth cervical, the temperature reaches as high as 106, 107, 108°, and even higher, as in one of my cases, as high as 111°. This is a central temperature from the destruction of the automatic centre of temperature control. Respiration may be compromised from the injury of the phrenic segment of the cord, which corresponds to the fourth and fifth cervical. With fracture in the upper dorsal region, the functions of the abdominal organs are greatly disturbed, and there is a paralysis of peristalsis, and enormous tympany may result; respiration may be impaired by the intra-abdominal pressure upon the diaphragm. In fractures of the spine above the second lumbar sphincteric control is destroyed. Of the secondary cause of death the most prominent are vesical infection and ascending sepsis to the kidney. Next in frequency is the decubitus infection. The former can be avoided in a large per cent. of the cases by permitting the bladder to overflow from the beginning and refraining

absolutely from using the catheter. If the catheter has once been used and decomposition takes place, then it must be continued. Relaxation of the vesical sphincter is favored by transprocteal massage. The decubitus can be avoided or retarded by a water bed, air cushion, frequent changes of position, and by dermal cleanliness.

STATISTICS. John Chadwick Oliver reports 57 cases of fracture and dislocations of the vertebra: 50 of these developed nerve symptoms after the injury; 7 showed no evidence of spinal involvement.

Areas involved: Cervical region, 23; dorsal, 18; lumbar, 10; dorso-lumbar, 2. In 4 cases location not specified. Deaths, 39 to 68 per cent.; of the 23 cases in cervical area, 22 died, 95 per cent.; of the 18 dorsal cases, 10 died, 55 per cent.; 5 were discharged as improved and 3 as cured; recoveries 16.6 per cent. Of 10 lumbar cases, 6 died; 1 improved; 3 remained unchanged; no complete recoveries. Of 2 dorso-lumbar cases, 1 death, 50 per cent. Of the 4 where location was not given, 2 died, 50 per cent. Considering only the 50 cases which showed nerve symptoms, 41 died, 82 per cent.; 8 of the 50 cases were operated; 6 of these died, 75 per cent.; 2 unchanged; 8 operated: cervical, 4; result 4 deaths, 100 per cent.; dorsal, 2; 1 death; 1 unchanged, 50 per cent.; lumbar, 2; 1 death; 1 unchanged, 50 per cent. Of the cases operated, therefore, there is a nil percentage of improvement or recovery. Non-operated cases—mortality: cervical, 94.8 per cent.; dorsal, 72.8 per cent.; dorso-lumbar, 50 per cent.; lumbar, 55.5 per cent.

Thorburn collected 56 cases operated upon. Result: 38 deaths, 67.8 per cent.; 18 recovered from the injury; 2 recovered from cord symptoms; 16 showed little or slight improvement.

Samuel Lloyd collected the following statistics on operated cases:

Cervical region.	Immediate operation.	Later operation.
Deaths	21	2
Recovery	0	2
Improved	2	1
Not improved	0	4
Subsequent death	4	3
	27	12

	Immediate operation.	Later operation.
Dorsal region.		
Deaths	23	5
Recovery	4	10
Improved	9	18
Not improved	6	16
Subsequent death	7	16
	49	65
Lumbar region.		
Deaths	4	4
Recovery	1	6
Improved	1	6
Not improved	0	4
Subsequent death	0	2
	6	22
Sacral region.		
Deaths	0	0
Recovery	0	1
Improved	0	3
Not improved	0	0
Subsequent death	0	0
	0	4

The results of these operations are anything but gratifying; out of 185 operations there were only 24 recoveries and 40 improvements. There were only 12 improvements by immediate operation; that is, there were only 12 that improved from the symptoms at time of operation. From various statistics of cases not operated, and from our experience, the immediate mortality is no small percentage. The number of recoveries in 82 immediate operations was 5. The recoveries without operative intervention far exceed this number. The number of recoveries with late operation is a little more gratifying; there were 19 recoveries in 113 operations, which, when compared to the number of late recoveries without operation, may be considered as giving us some justification for the late operation. Lloyd's results are about 50 per cent. better than Chipault's. Chipault published in 1894, 167 cases operated for fractures of the spine; 12 recovered and 24 improved.

INDICATIONS FOR AND TIME OF OPERATION.

In the cases that have come under my observation it has been difficult, and many times impossible, to ascertain whether I was

in the presence of a case of division of the cord or reaction of the cord due to trauma. Therefore, I always hesitate to operate until I am satisfied that the cord is not completely divided. The immediate complete bilateral circular paralysis of both motion and sensation is the only positive evidence of division of the cord. Where there is definite evidence of fracture or dislocation with division of the cord by fragments, operation is contraindicated and should not be performed. Where there is evidence of compression by blood or small bone fragments with fracture or dislocations, as shown by the fact that the paralysis is not immediate, not circular and not complete of both motion and sensation, an immediate operation may be indicated. Where they are persistent, the operation should be performed.

John Chadwick Oliver divides the surgeons into three groups: 1st, those who advocate operation in every case of injury to the spine in which cord symptoms are present. 2d, those who abstain completely from operation. 3d, those who advise operation in selected cases. We belong to the last class of surgeons.

Eugene Hahn[1] advises operation as early as possible, and particularly in cases of compression due to fractures of the arch, which always result from direct violence. However, he says the question of early operation is not settled as yet.

Andrew McCosh condemns the waiting and watching policy. He advises early operation as being of the utmost importance, unless severe shock is present. Kocher is of the opinion that operation can be delayed and advantageously performed after long continued pressure has been present. There are several cases on record where patients were apparently benefited by late operation. This is in consonance with a mild and gradual paralysis from neoplasms within the canal, but one cannot see how that type of pressure would be exerted by a displaced fragment, but it might be by the callus of bone repair.

Carl Lauenstein records a case in which an excellent result was obtained by intervention five weeks after injury. Paraplegia, rectal and urinary symptoms, and trophic changes were all present in this case. This is no proof at all that there was compression or that operation had anything whatever to do with the result, as the

[1] Deut. Ztsch. f. Chir., 1902, vol. lxiii, p. 995.

train of symptoms and the result obtained occur frequently from contusion and with fracture without compression.

McCosh records a case in which paralysis had been present eight months and yet complete recovery occurred after operation.

L. A. Weeks reports a case by Huss in which recovery followed surgical intervention one month after the injury.

Allen Starr reports a case of compression of the cauda equina of one year's standing. Operation was followed by partial recovery. Some anesthesia persisted.

Samuel Lloyd says: "In my opinion we should wait until the period of shock is passed and until there is evidence that there will be no spontaneous recovery." If, after this period, the patient still continues to improve, no operation should be considered, but as soon as the symptoms begin to show retrograde phenomena, or seem to have reached the end of improvement, operation should be undertaken. This rule is not applicable with any degree of force or regularity as far as our observations tend. *Recovery after operation, before a period of two and one-half years has elapsed, cannot positively be interpreted as playing any part in the production of the result, except in the cases where fragments or foreign bodies were compressing the cord.*

SYRINGOMYELIA.

Syringomyelia is a cavity situated in the posterior horn or horns of the gray matter, either connected with or independent of the central canal, and extending upward and downward for a limited distance or throughout the entire spinal cord. The disease has been known since the sixteenth century; it has occasionally been found in postmortems of premature fœtuses or in those of individuals who did not exhibit symptoms intravitam. Morgagni and Santorini found in a postmortem of a Venetian fisherman a tubular cavity in the spinal cord independent of the central canal. The present name of the disease was given to it by Nonat[1] in 1830. In 1869, Hallopeau advanced the theory that syringomyelia is not merely a dilatation of the central canal, but an independent cavity

[1] Traité de la moelle epiniere et de ses maladies, Paris, 1827.

resulting from the softening or degeneration of the periependymal glial tissue, which was previously inflamed. Several of the early writers on this subject emphasized the relationship between the formation of the tubular canal within the cord substance and a hydromyelia on the ependymal canal. In 1875, Th. Simon and Westphal considered syringomyelia as being absolutely independent of the central canal. Hoffman, of Heidelberg, admits that syringomyelia results from degeneration of periependymal glial tissue, but he does not deny the fact that congenital ependymal epithelial displacements of the central canal may have something to do with the proliferation. Wald. Gerlach, 1894, was of the opinion that congenital anomalies of the central canal were predisposing factors of syringomyelia. More recently, Schlessinger, Hoffman, Minor, and others, favored this relationship. It is, therefore, certain, say Leyden and Goldscheider, that "in the anomalies of development of the central canal there is a hyperplasia of the periependymal glial tissue, the relation and importance of which, however, is not yet fully established." The disease has been carefully studied during the last quarter of the nineteenth century, and about 300 cases have been reported in the literature. Schultze and Kahler deserve credit for their clinical descriptions. Schlessinger's classical monograph has elucidated many points on this subject.

Embryological Considerations. About the sixth week of intrauterine life the central canal is very wide and occupies almost the entire cord. In the course of time it gradually contracts and subdivides itself into two halves. The anterior half forms a central or ependymal canal, while the posterior half contracts until its walls come together and finally form the posterior septum. A failure of closure of the posterior half leaves a congenital cavity within the cord. "The central canal may remain imperfectly contracted and a syringomyelia may develop in connection with it. Probably most cases of syringomyelia are developed on the basis of embryonic defect." (Dana.[1]) The central canal, which is nothing else than an infolding of the ectoderm, is lined with epithelial cells, which differentiate themselves in the course of time and become cylindrical. It should not be forgotten that they are

[1] Treatise of Diseases of Nervous System, p. 337.

of epiblastic origin. The periependymal glial cells spread throughout the substance of the cord and are differentiated epithelial cells. A proliferation of glial cells and fibers (dendrites) forms a tumor mass which has frequently been mistaken for a sarcoma, which is a gross embryological error, because sarcomatous tissue is of mesoblastic origin, while glial cells are epiblastic.

Pathological Anatomy. While neuropathologists disagree as to the origin of syringomyelia their findings are uniformly the same. Examination of a cord, even before its section, reveals a bulging on the posterior half of the cord, which fluctuates on palpation. On section, one or several cavities are found extending upward and downward, either for a limited distance or through the entire cord up to the bulb, and occasionally involving the latter. Primarily, the cavity is more commonly found in the cervical swelling of the cord. The cavity occupies almost invariably one or both posterior horns, just behind the commissure and close to the central canal. The latter is not necessarily dilated, and in some cases is so contracted that it is almost impermeable. Again, the syringomyelic cavity may communicate with the central canal and form one large cavity, impressing one that the condition might be a primary hydromyelia. The tube may be patent or may be subdivided by septæ, either lengthwise or laterally, making single or multiple cavities. It may communicate with the fourth ventricle or end near it in the subarachnoid space. The shape of the cavity is tubular or triangular, and it is lined with cylindrical epithelium, similar to that of the central canal. From this histological fact we are led to believe that it is not likely that columnar epithelial cells can develop from glial cells, notwithstanding they were both originally ectodermic cells before differentiation took place. This epithelial membrane is surrounded by partly proliferated, partly degenerated glial cells. The consistency of this cellular element is sometimes so sclerotic, so hard, that it can be extracted like a foreign body—a rod or a pencil—from the substance of the cord. Here and there the sclerotic tissue softens and forms new smaller cavities. There are scattered areas of hemorrhage and of myelitis resulting from it. The arteries are sclerotic and the veins dilated. The cells in the anterior horn exhibit degenerative changes. The lateral columns of white substance may be either displaced without

being injured or they may be atrophied by compression. The posterior columns, with the exception of the comma tract of Schultze, are free from degeneration. The anterior roots are atrophied only where there are degenerative changes in the anterior horn. The posterior roots suffer changes from compression. The spinal ganglia are usually normal. The pia is thick in many cases. In the peripheral nerve there is a thickening of the peri- or endoneurone (Steubeuer, Landhaus). If the tube reaches the medulla, the nuclei of the trifacial, hypoglossal, vagus, and glossopharyngeal may be involved.

Etiology. There is no definite etiologic factor in this condition. The disease is dependent on some embryological abnormalities, and there are etiological factors not well understood which produce changes in embryonal defects. Trauma seems to be one of the most important factors in developing the congenital tendency. Infectious diseases have been deemed the exciting factors, but it seems that they are mere coincidences. Syphilis and alcoholism, which are the chief exciting factors of so many diseases, do not seem to play any rôle in syringomyelia.

Age and Sex. Schlessinger's statistics of 190 cases show:

	Males.	Females.
One to ten years	4	1
Eleven to twenty-three years	36	18
Twenty-one to thirty	53	25
Thirty-one to forty	30	12
Forty-one to fifty	4	7
Fifty-one to sixty	3	3
Above sixty years	3	1
	133	57

From these statistics one must conclude that trauma has little if any etiological influence, as the male spine in middle life suffers enormously more trauma than the female.

Symptoms. One cannot understand the symptoms of this disease, and in fact of any of the spinal diseases, without a definite knowledge of the anatomy and physiology of columns and ganglionic cells. The syringomyelic process involves one or both posterior horns, immediately behind the commissure. It occasionally com-

presses the posterior columns; it is associated with changes in the anterior horns; it displaces or compresses the lateral forms of the white substance. It will, therefore, have sensory and motor disturbances, changes in the reflex and trophic conditions of the extremities, and derangements of gait.

Disturbances of sensibility are typically characteristic of this disease. Patients have an almost perfect tactile sensibility, but have lost that of heat and pain. Occasionally heat is mistaken for cold, and vice versa, a phenomenon which is called "syringomyelic dissociation." In very rare instances an anesthesia of the skin and mucous membrane has been noticed (Dejerine). Subjectively, patients complain of pains, usually in the upper extremities. They are lancinating in character, and are often mistaken by the patient for rheumatic pains, and by the physician for tabetic pains. The preservation of tactile sensibility is explained by the fact that in the majority of cases the posterior columns of the fasciculus cuneatus and fasciculus gracilis are not involved, they carry the tactile impulses. The perversion of loss of sensibility to heat or pain is due to the destruction of a zone of ganglionic cells from which originate the axones that go to make up Gowers' column which conduct the impulses of heat and pain.

Motor Changes. There is muscular twitching and muscular atrophy, either uni- or bilateral. The upper extremities are usually involved and begin with the small muscles of the hand, resembling in this respect the clinical picture of progressive muscular atrophy, Aran-Duchenne type. Occasionally the muscles of the shoulders only may be involved. The muscles of the trunk may next be involved, those of the abdomen, and finally, rarely, however, the lower extremities. The extent of the muscular involvement and the group of muscles injured depends upon the extent and topography of the destruction of the anterior horn.

The cutaneous reflexes are generally increased. The reflexes in the upper extremities are absent, while in the lower they are exaggerated. This is the case if the lesion is located in the cervical region. If the disease involves the lumbar region, destroying the centre of the patellar reflex, then, of course, the latter disappears.

There are trophic changes, viz.: glossy skin, hypertrophic nails, herpes and ulcers; accidental cuts heal either slowly or never; there are trophic changes in the bones and joints, producing a syringomyelic arthropathy. Hugh T. Patrick, in the *Journal of Nervous and Mental Diseases*, December, 1898, draws attention to some striking manifestations in his cases. The great sensory disturbance and the spontaneous loss of toes; and in 1897, before the American Neurological Society, he reports a case of syringomyelia in which anesthesia and analgesia more closely corresponded to the tegumentary sensory representation of the segments of the spinal cord than any reported up to that time. A second case had a broad area of analgesia and smaller scattered areas of anesthesia. The reverse is obtained in trunk anesthesia of tabes, as shown by Laehr, Bonnar, and Patrick. Scoliosis or kyphosis is often present. As in tabes dorsalis, there is here a tendency to spontaneous pathological fractures. There may be changes in taste, in vision, bulbar symptoms, disturbances of the vasomotor centres, etc. If the bulb is involved and there is compression upon the brain, there is a complex of cerebral symptoms rendering the clinical picture more obscure. Schlessinger, in his monograph published in 1895, describes five distinct types:

1. One in which motor, trophic, sensory symptoms, and few other irregular symptoms are present.

2. A motor type similar to amyotrophic or spastic paralysis, in which the chief disturbance is motor, while the sensibility remains normal for years.

3. One in which the sensory disturbances predominate.

4. One in which the trophic disturbances are more conspicuous. If there is mutilation of the extremities it affects the type of Moran's disease. In this type there are intense neuralgic pains, anesthesia of the skin and destructive whitlows.

5. One in which the posterior columns are invaded with gliosis. (Oppenheim.)

From the pathological changes and the clinical course it is fairly safe to assume that the great element of destruction is the pressure from accumulating products of degeneration, or the excess and

retention of secretion of the columnar cells lining the cavities. This pressure can be relieved, when circumscribed or even fusiform, by a subdural drainage, the same as indicated in cerebral hydrocephalus. For this purpose, however, a horsehair seton passed through the cord into the cavity, and knotted on its surface beneath the dura, should suffice for permanent relief of pressure, on the same principle that metallic and glass tubes were used by Charles Ballance for ventricular hydrocephalus. Where the disease is pathologically represented as a solid ligneous mass it might be extracted through the posterior column or commissure of the cord by careful blunt dissection, as one would with a foreign body and as Braun removed the intermedullary bullet.

Diagnosis. The disease can and has been confounded with progressive muscular atrophy, leprosy, multiple neuritis, hematomyelia, tabes dorsalis, scleroderma, acromegalia, and others. In this the surgeon should corroborate the neurologist. It is with the hope that surgical intervention may avail for the relief of this otherwise incurable condition that we have devoted so much space to its detailed consideration. We have not yet had an opportunity to operate a case.

Prognosis. The prognosis is "finally fatal," but the course of the disease is very long, ranging from five to twenty years. Occasionally patients may not develop marked symptoms during life, as was shown by postmortems of individuals with syringomyelic cavities who had had no pathognomonic or recognized symptoms.

Prognosis without Surgical Intervention. It seems to us from a theoretical standpoint this disease, at least in its circumscribed form, offers a field for surgical intervention. As soon as opportunity presents itself I will perform a subdural drainage with an inabsorbable seton which will keep a permanent communication between the syringomyelic canal and subdural space, and insure an equalization of pressure, which should stop the advancement of the disease, even if it does not permit restoration of function in some of the compressed ganglion cells and axones.

TUBERCULOUS OSTEITIS OF THE VERTEBRÆ; VERTEBRAL CARIES; TUBERCULOUS GRANULOMATA.

In this chapter we do not intend to describe in detail vertebral caries. We will consider only that phase of the pathological process which directly or indirectly may produce pressure symptoms upon the cord. In other words, we will deal principally with the tuberculoma, which should be regarded as an extradural tumor.

Spinal caries was first described by Percival Pott, in 1779. Since that period, the pressure symptoms of the cord have been differently attributed by various authorities. Ollivier thought that the cord was compressed by the bony deformity pressing upon it with its sharp angle directed posteriorly. This has been proven, in the course of time, to be untrue. Repeated postmortems have demonstrated beyond a doubt that the cord may be free of compression even with very sharp angular deformities of the bony elements. The spinal cord follows the angulation of the bony canal, and unless there is displacement or fracture of the respective vertebræ the cord does not suffer from pressure. Kahler and Schmauss ascribe the compression symptoms to a lymphatic edema, the result of compression. Ziegler believes that the compression produced by the bone leads to an anemia of the cord, which is responsible for the symptoms. The partisans of the lymph stasis theory state later that it is followed by a swelling and softening of the nerve substance in the cord, which is due to an active inflammation or reaction myelitis. The inflammatory process may reach the cord by a propagation from the meninges, the tuberculous process invading the cord either by direct continuity of destruction through the septæ or bloodvessels. The latter may be obstructed, the arteria centralis principally, producing a softening of the medullary substance. This, however, is of no great pathological significance. Strümpell is the first who conceived the idea that compression of the cord was mechanical in origin and due essentially to the pressure of extradural tuberculomata acting as extradural tumors. Tuberculous caries of the spinal column is of importance when we consider the enormous number of cases, and also the amount

of damage which it causes to the spinal cord. Vulpius, studying the statistics of Billroth, Mohr, Lorenz, Hoffa, and Beuthner, found that among 10,000 surgical cases 44 were vertebral caries. He also estimated that the latter represent one-fifth of all bone diseases.

In order to thoroughly understand the cord symptoms in vertebral caries it is essential to have a clear knowledge of the evolution of the pathological process which takes place in the bone. The tuberculous process originates practically always in the body of the vertebra, principally in the spongy substance. Occasionally, very seldom, however, it invades the small articulations and the arches. If this be the case, the first two cervical vertebræ are concerned.

The bone changes may be subdivided into two stages:

(*a*) Granulation focus (Fungous osteomyelitis). One or several small cavities form in the spongious substance of the bone, containing tuberculous granulation tissue. If coagulation necrosis takes place, the cavities are filled either with cheesy material or tuberculous pus.

(*b*) Tuberculous necrosis. If there be considerable destruction of the bone, absorption is not possible. The destroyed segment forms a sequestrum. The cheesy mass is separated from the normal bone by a zone of tuberculous granulation tissue; at first it is reddish in color, and at this period it is very difficult to distinguish from the healthy tissue; later, however, on account of circulatory disturbances, this mass becomes grayish and finally yellow. If absorption of the fluid takes place it becomes an encapsulated caseous focus. As the substance of the body of the vertebræ is being destroyed it gradually compresses, the result being a deformity. When the tuberculous process ruptures through the posterior wall of the body of the vertebra it elevates the periosteum and gradually invades the spinal canal, compressing the cord with the accumulation products of the tuberculous disease in its circumscribed connective tissue walls. This is always situated anterior to the cord and nerve roots. The spinal cord moulds itself to the bony deformity, but the granuloma encroaches upon and com-

presses it, inducing paraplegia. The destruction may have been going on for a considerable time without compression symptoms being present. Trauma is generally responsible for the rapid collapse of the body. For a short period of time the cord may be compressed by a large abscess under tension as well as by a tuberculoma. The segment of the spinal column usually involved is from the middle dorsal to the middle lumbar. The cervical region may be the seat of attack, although rarely. Generally speaking, one vertebra is affected. There are cases, however, where two or three and even more than three are invaded.

In sudden collapse with displacement of the fragments, the cord is damaged exactly as in a fracture and dislocation of the vertebræ.

The tuberculous process invades the meninges, and some authorities think that compression is due to a localized meningitis; furthermore, that the inflammation is transmitted to the cord substance itself. These changes, however, are pathological curiosities.

In compression due to a tuberculoma, the cord is usually bent and flattened. Its nerve elements are crowded and contracted. For a long time there may not be trophic or degenerative changes in the cord, because it adjusts itself. Long standing compression, however, produces degeneration of the axis cylinders and ganglion cells. There is a sclerosis of the walls of the bloodvessels, an invasion of granulation cells at the seat of the trouble, and the glial and connective tissue elements undergo fungoid changes. Finally the cord elements may be replaced by connective tissue, with ascending degeneration of the posterior columns and descending degeneration of the anterior columns.

Symptoms and Diagnosis. The cases that come to the surgeon have long passed the lymphatic stage or anemia of the cord. They are generally cases in which the compression is affected by a tuberculoma. It is true, however, that it is impossible to differentiate from the symptoms, whether we have to deal with a simple reaction myelitis produced by the tuberculous inflammatory process, or whether it is a compression myelitis due to a tuberculous tumor; the former condition, however, is very rare. The only criterion

in this differentiation is the long standing symptoms of myelitis without the slightest attempt at amelioration.

As indicated in the beginning, we will consider the tuberculoma principally. It is practically an extradural tumor situated on the posterior portion of the vertebral body and in front of the cord; if it is of considerable size it may spread to the sides of the cord. It is never, however, posterior to it. From this we can understand that the primary symptoms will be purely motor as the pressure concerns the anterior or the anterolateral columns. Sensory disturbances may take place, not by compression of the posterior columns, but by pressure against the posterior roots at their exit, and also on Gowers' column. From the symptoms one can accurately estimate the location of the tuberculoma, that is, which cord segment and which column is compressed. One cannot, however, judge from the symptoms whether the cord is merely compressed without having undergone degeneration, or whether there is degeneration of the cord substance. In localizing the tuberculous tumor it should be borne in mind that one is likely to make the error of estimating the tumor too low. A given cord segment is situated above the respective vertebra.

The topography of cord segments in their relation to the vertebral bodies must be clearly pictured in the mind of the diagnostician. The splendid work of Sir Victor Horsley, who has done so much to elucidate this condition, should be carefully studied by everyone contemplating work in this line.

Prognosis. The prognosis in paraplegia of spinal caries is always grave. Statistics from Billroth's clinic, quoted by Oppenheim, show that out of 97 patients, 48 died, 22 were cured, and 11 remained unchanged. Gowers states the paralysis due to vertebral caries is the most favorable of all types of paralyses. Generally speaking, the prognosis does not depend so much upon the age of the individual, nor upon the intensity and extent of the symptoms, as upon the amount of damage done to the cord substance, which does not allow of repair if the pressure has been long continued. Operative procedure must, therefore, be timely.

Operation. The operation for tuberculoma is a simple laminectomy. (See laminectomy.) Displace the cord to side, expose the granuloma, remove it with a bone curette, fill the cavity with a Moorhof plug, replace the laminæ and close without drainage. It is usually not necessary to open the meninges. One should not hesitate to extensively curette the vertebral bodies. If the wound heals without suppuration and the cord has not long been compressed the paraplegia rapidly disappears. If a mixed infection follows, the cord may be destroyed and a permanent paraplegia result, as occurred in one of my early cases.

Technique of Laminectomy. Before proceeding with a primary incision it should be definitely determined by the operator whether his plan is to extirpate the spinous processes and laminæ entirely or whether the plan is to preserve them. If the former is decided upon, longitudinal incision should be made parallel to the spinous processes on the operator's side of the middle line. The incision should extend along down the side of the processes close to the bone. After thoroughly exposing the muscle a blunt dissection may be made on the lateral surface of the processes to the laminæ. The attachment of the flap to the tip of the processes is then divided and a similar blunt dissection made on the opposite side of the processes down to the laminæ. The hemorrhage, which has been considerable, can now be checked by gauze packing. The interlaminar spaces of one, two, or three vertebræ should be exposed and the conical rongeur-drill, which I have adapted for this purpose, should be used to puncture the laminæ at the base of each transverse process. The tips of our rectangular guarded bone cutting forceps can be inserted in each of these punctures, and the laminæ divided. The interspinous ligament is next divided. The spinous processes and laminæ can be readily lifted up with a sequestrum forceps. This plan avoids all malleting and concussion of the cord, and guards against its possible puncture; it hastens the procedure very materially.

The dura may now be opened if desired, and the cord inspected; or, if searching for a tuberculoma, the cord can be pushed to the side and the tumor recognized, on one or the other side, anterior

to the cord in the body of vertebra, where it always forms. The dura should be carefully sutured after the operation by catgut. If it is the purpose of the surgeon to conserve the processes and laminæ, then the H-shaped incision is preferable, leaving a septum of tissue, muscle, and skin one inch in diameter between the two parallel incisions, making the muscular blunt dissection one-half inch from the bone to the side. The laminæ should be punctured in the same way and divided with rectangular bone forceps. Then the interspinous ligament is divided and the flap turned half up and half down.

In replacing this, care should be exercised that the bone flap does not compress the cord. The flap should be closed by deep catgut sutures and superficial silkworm gut. Horsehair should not be relied upon, as tension is so great in these cases that this suture may give way. I had a case of compression by bone flap after operation, resulting in permanent paralysis. Since that time I have removed laminæ and spinous processes completely and found no permanent weakness of spinal column following this procedure. In fracture and dislocation it is always desirable to remove the laminæ, as the luxation frequently cannot be reduced at the operation and there is danger of compression of cord after the parts are replaced. In pronounced deformities following fractures one should not hesitate to remove the protruding edge of the fractured body of vertebra. This may necessitate a division of one of the spinal nerve roots. Traction should be made on the nerve to draw it well into the canal; it may then be divided and sutured at the close of the procedure. The greatest care must be exercised in the manipulation of the cord, as it requires but a slight degree of trauma to produce a zonal paralysis. In most of my cases a complete temporary paralysis immediately followed the operation, as shown in Case No. 7.

Mr. S., aged thirty-two years; occupation, printer. Admitted to Mercy Hospital, August 22, 1905.

History of Present Illness. In 1898, patient noticed for the first time some difficulty in walking. While endeavoring to catch a car he noticed that he was not as agile as formerly. In the follow-

ing weeks the difficulty became more manifest. It increased slowly and gradually until, in 1901, the gait was distinctly impaired. From 1901 to 1904 the patient was compelled to make use of a cane. In the last three months he was forced to make use of crutches. Three years ago patient noticed pain in both lumbar regions along the posterior region of the thighs and in both knees. The pains were not continued, were sharp at times, but not sudden, so that they were entirely different from the classical shooting pains usually experienced in tabes dorsalis. At times the pain took the form of cramps; again they were neuralgic in character. From time to time patient noticed muscular spasms, which he chose to qualify as "twitchings."

Since September, 1902, patient did not experience any pain. Had no gastric symptoms at any time; no gastric crises; was usually constipated. In last four years had great difficulty in making his bowels move. Lately he has noticed a weakness of the rectal sphincter, especially when taking purgatives. He describes the phenomenon by saying "I can't control my bowels." The same derangement has been noted on the part of the vesical sphincter. Patient has frequent desire to urinate, but sometimes fails to urinate when he has the desire. If that difficulty appears, he usually overcomes it by pressing upon the bladder, which is followed by the evacuation of the urine. He has several involuntary emissions of urine at night. These sphincter troubles appeared about one and a half years ago.

Patient is not nervous; has not changed in character and temperament of late. His memory has not been as good during the last five years as it was previously. No change in vision, speech, or deglutition. Lately, however, he noticed a slight hesitancy when beginning a new sentence. Sleeps well; has not lost in weight. For the past four years patient has been deaf. The condition was not induced by any accident; he cannot account for its appearance. In the last six months his sexual appetite has considerably diminished. He seldom noticed an erection; has no night emissions.

Previous Illness. Patient had mumps, measles, and chickenpox, in childhood, without sequelæ. Had a specific venereal ulcer

at the age of sixteen years; when he was treated for one year. Four or five years later he took antisyphilitic treatment for eight months. The disease was diagnosed by a physician and was fully confirmed by postsyphilitic symptoms. At various times he had mucous patches in the mouth and the throat. In 1896, he had what he calls sores on the hands and feet accompanied by severe nocturnal headaches. The administration of iodide of potassium greatly improved his condition and finally cured him. He used and probably abused the use of alcohol up to three years ago. Smokes, but not immoderately. Has been married four years; no children. His wife had no abortions.

Family History. Father died with general paresis at the age of fifty-six years. Mother died with tumor of the kidney, at the age of fifty-five. Wasting symptoms preceded her death. Patient says: "We had a good many cancers in the family. Cousins, aunts, and collaterals of the family died with cancers of the throat, breast, stomach, etc."

Examination of Patient. Medium stature; general nourishment fair; teguments have a normal appearance.

Eyes. Pupils are equal in size, regular in their contour, and respond very well to light and accommodation. Wears glasses; is able to read without difficulty.

Speech. By paying special attention, and for some time, we notice a little hesitancy in speech, particularly when beginning a sentence. The tongue shows a fine fibrillary tremor.

Examination of Thoracic Organs. Lungs, negative. Heart, negative. Abdominal organs, negative.

Reflexes. The reflexes of the face are increased. The cutaneous reflexes in general are slightly increased. *Patellar reflexes, however, are absent.*

Sensation. Patient has a perfect sensibility, both tactile and caloric. We were unable to find even a small area in which the sensation was impaired or absent. By running a needle along the surface of the skin, patient feels equally the touch of the point of the needle.

Motion. In recumbent position patient is able to flex, extend, rotate, abduct, and adduct his lower extremities. Flexion of the

knee is accomplished almost normally on the left side; flexion of the right knee, with some difficulty. He is able to extend his legs, but toward the end of this action the heels fall down on the bed involuntarily. He flexes and extends his toes almost normally on the left side; flexion and extension of *right* toes is difficult, limited, and imperfect. He is able to lift his legs. The left heel can be elevated eighteen inches above the level of the bed, while the right one can be elevated only twelve to fourteen inches above that level. The distances above mentioned are considerably reduced if he elevates the legs four or five times in succession. Generally, we may say, that after repeated muscular contraction a fatigue is distinctly noticeable. Patient calls it exhaustion. Muscular sense is perfect. No muscular atrophy. Tension of the musculature of the thigh and leg is slightly diminished. Patient is able to walk eight blocks with the support of crutches. Without crutches he walks with difficulty one-half block, maximum. Gait decidedly not ataxic. The first step is very difficult, but once started he is able to make the following steps. Walking, patient rotates his trochanters around an anteroposterior axis of the pelvis. His gait can best be compared to the gait of children with congenital double distal dislocation of the hips. He is unable to walk in the dark. Standing up with his heels together and closing his eyes, he loses his equilibrium.

Examination of the Spinal Column. The spinal column shows no deformity; no deviations. By pressing along the spine and spinous processes we find the following painful points: (*a*) Fourth, fifth, sixth, and seventh cervical spinous processes; (*b*) the middle dorsal spine; (*c*) the lumbosacral junction.

Babinski's sign present and more marked on the right foot.

August 24, 1905, pain spasmodic in character, that is, short, sudden pains located on the outer surface of thigh only. Is able to flex toes, but very little. August 25, 1905, same condition. Babinski's sign not noticeable. Slight muscular twitchings in the extensors of the thigh.

August 26, 1905, no improvement in flexion and extension of toes. Patient is able to flex his left knee, but very little.

Diagnosis. By Dr. Hugh T. Patrick. Compression of the spinal cord on its right side with a tumor at the eleventh dorsal vertebra.

Operation August 26, 1905. Compression of spinal cord from the right side behind, pushing the cord forward and to the left, making a groove or depression in the cord. Enlargement of lamina and base of transverse process at their junction, involving only the eleventh dorsal process. Meninges appeared normal; no elevation on the vertebral body anteriorly. Cord was *not compressed anteriorly* for the distance of four inches examined. Operation: Laminectomy and removal of exostosis.

Paraplegia complete after operation. Babinski absent; this, occurs even in cases where paralysis was only partial preceding the operation. It is, however, only a zonal or traumatic paralysis and entirely disappears as long as the centripetal and centrifugal axones are not divided or ganglionic cells severely traumatized; complete restoration always follows. One of the unpleasant features of this work is the length of time necessary to obtain results, six months to two years being required for a restoration of function. However, the time is not too long nor the labor expended too great, as otherwise the patient has before him no hope except a permanent paraplegia. In handling these patients after operation care should be exercised that too great pressure should not be exerted on the vertebral bodies, while moving them from one part to another and to their beds.

January 22, 1906, five months after operation, patient can move all muscles and stand in his training machine without support. Since that the improvement has been slow but progressive.

It is unnecessary to say that all these cases should be temporarily drained and all aseptic precautions taken, as infections are more likely to occur here than in the peritoneum. If the meninges become infected the case is likely to terminate fatally. Every precaution against bed sores (decubitus) must be taken. The bladder should not be catheterized; the patient should have a vaginal or procteal massage until overflowing is produced. The urine when started will continue to flow. If the catheter is once used it

will have to be used continually and decomposition of urine will result, which will necessitate frequent vesical irrigation, greatly increase the labor in caring for the patient, and very materially hazard his life, as vesical and ascending renal infection is the most common cause of death after operation for injuries to the spinal cord.

SPINA BIFIDA.

Spina bifida is a congenital malformation of the spinal column, meninges, cord proper, or ependyma, consisting of a protrusion either of the meninges or of meninges and spinal cord through a cleft, resulting from failure of coalescence of the borders of neural groove or absence of the vertebral arches.

Embryology. The nerve elements of the spinal cord are of ectodermic origin exclusively. The cord is an invagination of the ectoderm, forming a groove which is widely open at first, gradually closing to form a tube, the neural tube. The mesoderm supplies the serous, bony, and muscular elements, which arrange themselves around the neural tube. A mal-union, or absence of the involuting mesodermic elements which form the vertebral arches and spinous processes, will leave a cleft through which the meninges alone, or together with the spinal cord, will protrude posteriorly, because of lack of support.

The defective coalescence of the spinal processes may be either partial or complete. In the first instance the opening involves two or three vertebræ, either in the lumbar or cervical region, as these are the last to close; the lumbar is the more frequent. Complete absence of union is called rachischisis totalis and is an uninterrupted opening extending from the cervical to the sacral region. This variety, however, is extremely rare.

In the circumscribed type of spina bifida we find a protruding tumor, the size of which may vary from 3 to 15 cc. in diameter, having either a broad or pedunculated base. The sac usually protrudes posteriorly. Occasionally, very seldom, however, the sac bulges anteriorly; it escapes through the defective body or process or through the spinal foramina, as shown in the following

cases, and is discovered by accident. Several cases of this type are recorded in the literature. De Forest Willard reports a case in a child of two months, with a large cyst palpable through the right iliac fossa. The cystic tumor, which communicated directly with the spinal canal, bulged anteriorly when coughing. Its walls were the meninges, and the contents cerebrospinal fluid. Emmet reported a case, a woman, aged thirty-six years, with a very large cyst extending down into the pelvis. It was aspirated through the rectum and three quarts of fluid extracted. The patient died on the seventh day. Postmortem examination revealed a cyst formed of meningeal membranes, which protruded into the pelvis through the sacral foraminæ. Robinson operated on a case, a child, aged eleven months, who had a large cystic tumor occupying the entire right side of the abdomen. The patient had club feet; there was no tumor to be found posterior to the sacrum. A diagnosis of parovarian or broad ligament cyst of fetal origin was made. During the operation the surgeon found that the cyst communicated directly with the spinal canal, and that it was an anterior spina bifida. Patient died after ten days. Postmortem showed extensive defects on the right side of the last dorsal and first lumbar vertebræ. The pedicles of the transverse process of this vertebræ were absent. The first two lumbar vertebræ had an undeveloped point of ossification on the right half, while the third lumbar vertebra had no point of ossification at all. The spinal column was curved laterally, the concavity being directed toward the left. There was a marked dilatation of the ependymal canal. Bryant reports a case of anterior spina bifida, in a woman, aged twenty-five years, who died from a trauma. The tumor was discovered accidentally.

Varieties of Spina Bifida. Dana distinguishes three varieties:

(*a*) Meningocele, a protruding sac composed of meningeal membranes and cerebrospinal fluid only. This may be either: first, anterior, abdominal, or pelvic; second, posterior or dorsal tumor.

(*b*) Meningomyelocele, hydromyelia, a tumor composed of meningeal membranes, cerebrospinal fluid and spinal cord, including cauda.

(*c*) Syringomyelocele, composed of meninges, cerebrospinal fluid and spinal cord, with an enormous dilatation of the central canal or ependyma.

To these we may add, spina bifida occulta, which is a cleft of the spinal column without any visible protrusion of the contents of the spinal canal. In great defects, the cord is a velvet-like band containing bloodvessels and flattened nerve elements spread out under the meningeal covering. In circumscribed varieties the sac may be covered with skin and hair, or simply with a thin epithelial layer which, together with the pia, form a epithelioserous covering.

In the first variety of Dana the cord elements may be intact. In the second, the cerebrospinal fluid lies in the subarachnoid sac. The nerve elements of the cord protrude into the sac in two-thirds of the cases. The fibers are attached on the posterior and median surface of the sac *and form a part of the cyst wall.*

In the third variety there is a considerable dilatation of the ependymal canal, with complete or almost complete pressure atrophy of the spinal cord at the point of dilatation, with a paraplegia below that zone, as shown in the following case.

De Young R., aged three years.

Family and Previous History. Absolutely negative.

Present Trouble. A mass the size of a silver quarter was noted at birth in median line of back at about the level of the dorsolumbar junction. This at first was flattened and of a fluctuating consistency. A serosanguineous fluid discharged from the most dependent portion of tumor. This continued during the first year, but finally yielded to local treatment. The tumor mass gradually increased in size, but the growth during the past six months, *i. e.*, before coming to the hospital, was very rapid. On entering the hospital the mass was the size of a small orange, globular in shape, rather tense, fluctuating in consistency. There was no tenderness nor evidence of inflammation in the tumor mass nor in the adjacent skin. The head of the child, from birth, has been large, and tended to approach the hydrocephalic type. From birth the child presented a complete paraplegia with absolute motor paralysis, anesthesia, and analgesia; also loss of sphincter control. Mother

says the teething and talking began at a normal age, that is, as compared with her other children.

Diagnosis. Syringomyelic spina bifida. Three injections with Morton's fluid were made. Some reaction, but no appreciable benefit.

Decision. Cure of spina bifida would not materially benefit without curing paraplegia.

Operation. Freeing of sac, dilatation was central. That is, it was a dilatation from an accumulation of material within the low canal portion and filum terminale portion of the ependymal canal, producing a pressure destruction of the caudal nerves just below the exit from the conus and not producing a destruction of the conus ganglionic cells or axones. Careful dissection was made, separating the dura and sac from other tissues down to the bone border. Cord was found dilated from centre with complete pressure destruction for an inch or more. Central cicatricial mass dissected out. Ends of caudal fasciculi, upper and lower, united with catgut suture, and the divided lateral nerves (lumbar plexus) attached to line of spinal suture. Electric test was then made, one pole at upper and one at lower end of cord, and with both poles on lower segment there was pronounced muscular response in both lower extremities. Dura then closed with single row of catgut sutures. Closure of opening in bony spine. Both spinous processes were fractured at the attachment to transverse processes and drawn to median line and united with heavy catgut sutures. Drain was placed (one-eighth inch perforated rubber) beneath the line of suture. Aponeuroses of quadratus drawn together over seam so as to retain lumbar muscle in centre line. Skin flaps supported by four silkworm gut sutures through lead plates. Skin united with horsehair. Silkworm gut drain. Cerebrospinal fluid was discharged for two weeks. Temperature 102° F. It, however, subsided, and case recovered. The feet changed in their temperature and color and "life expression" was very materially noticed before the patient left the hospital, December 20, 1905. Letter dated January 14, "Patient progressing nicely; no motion in extremities; the legs and feet have an expression of life about them."

Another letter, January 16, informs me that the patient is in splendid physical condition. The tumor in the back has not reappeared and the spine is apparently normal.

If the dilatation had been two inches higher, operation for the cure of the paraplegia would have been worse than useless and dangers of operation greatly increased, for in that position resection of sac and restoration of conformation of spine is all that could have been undertaken or justifiable. It must be borne in mind that the sacral and lumbar nerves pass upward a considerable distance in the spinal canal before they enter the cord or conus and have their neurilemma.

Etiology. The etiology of spina bifida is very obscure. Occasionally it is one of a series of congenital malformations. A plausible explanation for the ill-closure of the medullary groove is the traction by amniotic bands preventing the union of its borders. Still it appears to us that there is also an element of increased pressure from within, as in the anterior varieties failure of cleavage does not occur, but pressure seems to force the meninges through the foraminæ and bodies.

Symptoms. The general nourishment of the individual is usually below par. The mentality is defective. In cases of meningocele there are no motor or sensory disturbances. In meningomyelocele and syringomyelocele there are usually sensory disturbances, sphincteric derangement, and not uncommonly motor disturbances. In the latter variety paraplegia is usually present. Associated with the motor and sensory disturbances we find club feet, spinal curvature, and other deformities.

Diagnosis. If the spina bifida is posterior the diagnosis is generally not difficult, except in spina bifida occulta. In this type the vertebral cleft is covered with skin and hair, and there is no protrusion of the cord or membranes. Patients affected with this variety, however, are not free from symptoms; we may find in them anesthesia, club feet, and perforating trophic ulcers. The cases of anterior spina bifida are impossible of diagnosis before abdominal section.

Treatment. Treatment consists either in injection or excision of the sac. Injection has long been and still is in vogue. Morton's

fluid, which has the following composition, is the one generally used: Iodine, 10 grains; iodide of potassium, 30 grains; glycerin, 1 ounce.

Injection is not free from danger, and its efficacy is very questionable. We used it three times in the case reported above without effect, except a temporary disturbance of the central nervous system.

Excision of the sac seems to be the radical and more desirable procedure. The sac is best attacked from the side because the fibers of the cord are more frequently spread and attached to the median portion of the posterior wall, within the line of embryonal cleavage. When the sac is pedunculated it should be first freed from its attachment to the skin and neighboring structures, except its highest point, which is adherent to the skin; there an elliptical cutaneous flap should be permitted to remain attached to the sac. When the latter is freed to a level with the cord, a provisional ligature should be thrown about its neck without tying. The sac should be opened, carefully examined, and if the cord is not protruding, the ligatures should be firmly tied; an overstitch of catgut should give it additional support. If the base is broad the same procedure should be followed, except that after opening the sac and inspecting it, the ligature should be removed. It should then be amputated at its base and carefully sutured if it be a case of syringomyelia, and if the cord protrudes into the sac, the fibers of the cord should be freed from their attachment to the meninges and replaced in their normal position; the opening in the sac closed with a continuous chromoform catgut, or preferably, kangaroo tendon suture. If a complete syringomyelia exists the cord should be amputated in both directions from the centre of elevation to a normal anatomical zone; then a careful end-to-end suture of fibers should be made if the spina bifida be situated in the caudal zone. If above the caudal zone the cord should be freed and replaced within the dural sac without suture, the opening closed, with no hope of motor improvement offered the patient. In localizing the muscles supplied by the distal fibers, faradic current should be used. Our results have been most satisfactory after this technic, both immediate and remote.

Mayo Robson uses a median incision. He also leaves a segment

of the skin in place if separation of the dura from it is difficult. He advises that the meninges and skin should not be united on the same longitudinal line. In the clinic at Breslau the meninges are united longitudinally and the skin transversely. After removal of the sac, in order to prevent subsequent hernia of the contents of the spinal canal, the defect is repaired either by a muscular flap (Bayer) or by osteoplastic flaps (Selenko and Bobroff). Mayo Robson once transplanted periosteum and bones from animals for this purpose.

Prognosis. Of 647 cases of spina bifida, which died in England, in 1882, 615 were under one year of age. Of the 90 not operated, the great majority died within the first few weeks. Only 20 reached more than five years of age. The mortality in the treatment of spina bifida by injection of Morton's solution is 20 per cent. Statistics of the Clinical Society, in London, which includes 71 cases treated by injection, show 49 per cent. cured; 5.4 per cent. improved; 7 per cent. unchanged, and 38 per cent. mortality.

CONCLUSIONS.

The gray and white matter of the spinal cord down to the cauda is made up of—

(*a*) Intrinsic ganglionic cells (gray matter).

(*b*) Centrifugal cerebral axones (white matter of motor columns).

(*c*) Centripetal sensory axones from the spinal ganglia in which is located the trophic cell body of these axones, making up the sensory columns. The centripetal and centrifugal axones within the spinal cord are aneurilemmic.

(*d*) Intercommunicating or associating axones, which connect the various segments of the intrinsic ganglionic cells of the cord, and form the anterior ground bundle of white fibers, are aneurilemmic.

(*e*) Direct cerebellar centripetal axones from ganglionic cells situated in the posterior internal region of posterior horn, and close to the commissure leading to the ganglionic cells situated in the vermis superior of the cerebellum, are aneurilemmic.

(*d*) Gowers' tract, the axones of which originate in the posterior horn close to the commissure are also aneurilemmic.

(*e*) Neuroglia.

(*f*) The bulb, or medulla oblongata, is a continuation of the same ganglionic zones of gray matter in the cord and has all of the centrifugal and centripetal axones of the spinal cord; and, in addition, it has its own peculiar anatomical elements.

Nerves arising from the medulla are surgically essentially spinal nerves. Therefore, all of the "cranial" nerves, except those of special sense, are from a surgical standpoint essentially spinal nerves. The extramedullary motor and sensory axones are medullated and neurilemmic.

Nerves of special sense should be called cerebral nerves, as their trophic cell bodies are outside the cranium and in the organs of special sense. The centripetal axones of these nerves, with the exception of the olfactory, are all medullated and all aneurilemmic.

The extraspinal roots, both centrifugal motor and centripetal sensory, are medullated and neurilemmic.

The peripheral nerves of the bulb and cord (cranial and spinal) are medullated and neurilemmic to their nerve endings. The terminal dendrites are medullated and aneurilemmic. They possess, however, a limited potentiality of outgrowth of the axones beyond its neurilemma.

The cauda is from a surgical standpoint an intradural collection of extramedullary spinal axones, and is made up of axones with a medullary sheath and a neurilemma.

The sympathetic system is a chain of ganglia and nerve trunks. Their axones, except a few of the abdominal, are neurilemmic and non-medullated.

When an axone is divided, the entire portion distal from the trophic ganglionic cell body degenerates; proximally it degenerates for a short distance, and for a longer distance it atrophies.

When a ganglion cell is once destroyed, the degeneration of its axone or axones and dendrites is complete and the restoration of motion and sensation in its peripheral zone can only be obtained by anastomosis of its axones to other axones originating from

healthy ganglionic cells, as in operations for anterior poliomyelitic paralysis.

Ganglionic cells and aneurilemmic axones once destroyed never regenerate. All neurilemmic axones, centrifugal (motor) and centripetal (sensory), are capable or potent of both anatomical and physiological regeneration under favorable conditions. (For the great rôle played by the neurilemma in nerve regeneration we refer to the section on "Regeneration of Peripheral Nerves.")

Ganglionic cells in the gray matter of the cord never regenerate to functional potency.

Centrifugal motor axones within the cord never regenerate as they are aneurilemmic.

Centripetal sensory axones within the cord never regenerate, as they also are aneurilemmic.

It can, therefore, be seen that there is no regeneration of the white columns or gray matter of the cord after destruction or division; it has never been demonstrated experimentally nor authoritatively observed clinically.

All these principles equally apply to the bulb or medulla oblongata.

The spinal, cranial, sensory, and sympathetic ganglions once destroyed never regenerate. The caudal portion of the cord is made up of neurilemmic centrifugal axones from the spinal cord ganglion cells, and of centripetal sensory axones from cells in the spinal ganglia, all being neurilemmic, from the place they leave or enter the conus. They are, therefore, all capable of regeneration, the same as peripheral axones.

Spinal Roots. The extracordal or extramedullary and extrabulbous spinal and cranial axones are neurilemmic and potent of regeneration. Therefore, divided roots within the cranium and spinal canal regenerate.

Peripheral nerves, cranial and spinal, are composed of neurilemmic axones and are, therefore, capable of regeneration.

The nerves of special sense, the optic, olfactory, gustatory, and auditory, are composed of aneurilemmic axones, and are incapable of regeneration if once destroyed. In this particular they resemble

the columns of the cord. Their trophic ganglion cells are situated in the retina, Schneiderian mucosa, taste organs, cochlea, and vestibule, respectively. When these membranes and ganglion cells are destroyed, the cells and axones are incapable of regeneration.

The sympathetic nerve trunks are non-medullated, but neurilemmic and capable of regeneration.

SURGERY. Hemorrhage, concussion, and contusion without laceration may offer the same immediate symptomatic picture as that of division, so that a positive differential diagnosis may be practically impossible.

There is no direct relationship between the severity of the trauma and the degree of lesion in the cord. The element of time, and the order of appearance of symptoms is of great importance, and may be the only guide in the differential diagnosis.

Absence of paralytic symptoms immediately after spinal trauma does not justify the surgeon in assuring the patient that such symptoms will not appear. They may set in within a few days or even some weeks after the injury.

If paralysis is due to hematorrhachis the condition may be relieved by early spinal puncture.

Intra- or periarachnoidal hemorrhage from bullet or stab wounds may produce complete paralysis resembling that of a division of the cord. If the pressure be relieved the patient will survive and the paralysis will be temporary.

The majority of cases of transverse or incomplete traumatic irregular paralysis following fractures recover without operative treatment, which signifies an absence of spinal-cord division. Wherever there is immediate and complete circular paralysis operation does not benefit the patient in the least, as there has been a division of spinal neurones which never regenerate.

Surgical intervention in injuries to the cord should be resorted to only in cases in which the spinal cord is not completely divided except in the caudal zone. Immediate intervention will be of benefit when the cord is compressed above the cauda, or compressed and divided in the cauda. If operation is at all indicated there is no reason for delay as degenerative changes may take place in

the cells and neurones of the cord which would be as irreparable as its division.

In fractures of the spine without considerable displacement we are justified in assuming that the cord is not suffering continued compression, regardless of the degree of paralysis; operation is contraindicated. If this paralysis is due to laceration it will not be improved by operation. If it is due to contusion it will recover without operation.

Immobilization is most important in favoring the repair of the spinal cord and lessening the likelihood of connective tissue and callus compression at the site of injury. In gunshot and stab wounds with immediate paralysis, operation is contraindicated, except in the caudal zone, as the cord is probably severed, and its reapproximation will avail nothing.

After division or crushing of the nerves of the caudal zone there is a positive indication for an end-to-end suture of the various fibers, the same as in peripheral nerves. The individual muscle fasciculi may be determined by faradic stimulation.

In spina bifida centralis (paraplegia) in the caudal zone, resection of the atrophied portion of the cauda with end-to-end union is indicated.

Upper ependymal and true cord central spina bifida may be treated by ependymal arachnoidal drainage. In all non-malignant tumors of the cord laminectomy should be performed at the onset of paresis. Delay to complete paralysis is unpardonable, not to use a more forcible expression. Operation after complete paralysis from compression with degeneration is contraindicated.

In tuberculoma compression of the spinal cord the operation should be done at the onset of the symptoms of paralysis. Late operations, that is, after pressure necrosis of the cord has taken place, are worthless. The bone cavity should be filled with a Moorhof plug, as this lessens the liability of suppuration and hastens the process of repair.

In conclusion, surgery of the spinal cord, like surgery of other parts of the body, must be timely, *i. e.*, the operation must be performed before the pathological condition is advanced beyond the

possibility of repair. In our present positive, though limited knowledge, timely action means conservatism, while delay must be interpreted as timidity or inefficiency.

In citing these cases we do not include the great bulk of cases of fractures which recovered without operation prior to our present knowledge of the cord; tumors or granuloma, which had the symptoms of paralysis and which improved without surgical intervention nor the great number of cases of fractures of the spine treated by laminectomy which did not recover. A detail of these histories would have no value as they did not have back of them a knowledge of the potency or impotency of degeneration of the various portions of the cord. Nor do we place under this heading the histories of cases of nerve anastomosis, or peripheral nerve union for anterior poliomyelitis, as we feel they should come under the heading of surgery of the peripheral nerves.

Cicero B., aged fifty-nine years; occupation, farmer; admitted to Mercy Hospital, August 20, 1906.

History of Present Trouble. October 7, 1900, patient was working in the field plowing potatoes. As the plow ran over a little hill it suddenly turned over to the right. Patient fell on his right side with the plow, but was not hurt by it. He got up without assistance and was able to resume his work a few minutes after the accident. This happened in the morning. At 3 P.M. of the same day patient met with a similar accident. This time, however, his feet became tangled up with the reins, while his body fell on the right side. The horses stopped immediately after the plow turned over. With the assistance of a man, patient was able to get up, and resumed his work immediately. After this second fall he was free from pain and from any other symptom in his lower extremities. He had, however, considerable pain in his back along the lumbar portion of the spinal column. He continued to handle the plow until 6 P.M., notwithstanding the intense pain in his back. After supper time of the same day patient walked to town. There was no difficulty nor abnormality of gait; the backache persisted, however, with the same intensity. At 2 A.M., the morning following the accident the patient woke up on account of the pain in his

back. He got up, and as soon as he stood on his feet the pain ceased entirely. He walked around the room and the yard for some time, and when he returned and sat down in the rocking chair he experienced the same pain as before. Concluding that sitting down brought on the pain he decided to either walk or stand up.

The day following the accident he walked to town to consult a physician. The latter diagnosed it as "sprained back" and applied a plaster to the lumbar region of the spine. Returning from town, he was practically free from pain when sitting down. At noon of the same day patient experienced numbness in his feet. At 3 P.M. he laid down and at 5 P.M. while endeavoring to get up he noticed a considerable heaviness and numbness in his lower extremities. With some difficulty he got up and stood on his feet for a short time. The limbs, however, were unable to support the weight of his body. With some assistance he stood up for a short time. At 8 P.M., twenty-nine hours after the last accident, the limbs were completely paralyzed and unable to support any weight at all. At 11 P.M. of the second night the patient recollected that he had not urinated for fifteen hours. At midnight he was catheterized and a considerable quantity of urine extracted.

October 9, patient was in bed with an almost complete paralysis of the lower extremities; this, however, of motion only. He was able to move his toes very little for a few days. October 11, there was complete paralysis of motion of both lower extremities. The first three days after the accident patient was constipated and purgatives were ineffective. At the end of the third day he had a bowel movement. Ever since he uses an enema every morning. Whenever the feces are liquid patient is unable to retain them. For a year and a half patient made use of the catheter, not because he was unable to pass the urine but simply because he wanted to avoid the annoyance caused by its incontinence. In the past four and a half years patient has not used the catheter, and is able to urinate voluntarily. Involuntary micturition was rather an exception during this period of time.

After two months of complete paralysis of motion he commenced

to move the toe of his right foot. There was slow but gradual return of motion in the muscles of the right foot, leg, and thigh, and at the end of one year he was able to flex, extend, etc., his right lower limb. Yet he was unable to support the weight of his body. There was no improvement whatsoever in the left lower limb. In September, 1905, patient used braces and with the assistance of crutches he was able to move about, but states that his legs were unable to support him. In December, one of the braces broke and patient fell on his left hip. Ever since he has had considerable pain in that hip, especially when he is moved from one side to the other.

The backache, which was experienced soon after the accident, covered for a few days a large area in the lumbar region. The same localized on one point on the middle line of the back, which has remained painful all of these six years. The pain was neither assuaged nor relieved by change of position. Of late he has, in addition to the pain mentioned, pain on the side of the lumbar column, and about one inch from it. At various times he used faradic currents without avail. Patient's general health was good.

Previous Illness. For years patient had backache when working. "The weakness of the back" as patient chooses to call it, was especially marked before the accident. In infancy he had measles, whooping-cough, and a few other similar diseases, which he cannot definitely remember. As a young man he was always very healthy. Denies gonorrhea and syphilis. His habits have been good. Drank alcohol occasionally, but never to excess. Has four children living; one died in infancy. His wife had no abortions. She died two years ago.

Family History, negative.

Examination of Patient. Patient is tall, stout, and very well-nourished. His estimated weight is about two hundred pounds. Pupils react to light and distance. Mentally, normal. Thoracic and abdominal organs, negative.

Examination of Lower Half of Abdomen and Lower Extremities. 1. Sensibility. Right side, beginning with a line situated four fingers above the umbilicus and circular around the body to the

spinal column, and up to the tip of the toe, the condition of the sensation is appalling. Sensibility to light touch, tested by light wool, is absent in about 95 per cent. of the cutaneous area. In a few scattered irregular areas the light touch of wool is barely noticed. Sensibility to prick is present, yet considerably diminished as compared with the left side. Above the circular line described there is hyperesthesia. Sensibility to pain is present, but it has the same character as sensibility to prick. Caloric sensibility. Patient cannot discriminate between heat and cold. The application of hot water for five minutes does not give any other sensation than that of touch.

Left Side. Sensibility to prick, light touch, pain, heat, and cold, are all present and exaggerated to a certain degree. This is especially true about sensibility to prick and that of extremes of heat and cold.

2. Motion. Right limb: There is no visible muscular atrophy. The tonus of the muscles is decidedly diminished. He is able to flex, extend, abduct, adduct, and rotate the foot, leg, and thigh. The movements are, however, slow and hesitating. The limb is unable to support the weight of the body.

Left limb: There is a complete paralysis of motion in this limb except a very insignificant excursion of the toes. The paralysis is of the flaccid type; there is a visible muscular atrophy.

Superficial and Deep Reflexes. Tickling or pricking the right plantar region produced a sudden reflection of the limb, also a slight flexion of four toes, and an extension of the great toe. The latter, however, is not marked. The same action in the left plantar region produces the same sudden retraction, flexion of four toes, and a very pronounced extension of the great toe. Upon pricking the plantar region three or four times the leg suddenly retracts and enters into a spasmodic condition which lasts a fraction of a minute. The patellar reflexes are greatly exaggerated on both sides.

Muscular Sense. Only very slightly impaired. It can be said that it is practically normal.

No ankle clonus can be produced in the right leg. If the patient

touches the ground with his left toes, then the ankle clonus is marked in this leg. Babinski's sign is very pronounced in the left leg.

Response to Electricity. Right limb: All the muscles of the anterior and posterior region of the thigh, all of the muscles of the leg respond to faradic currents. While the extensors of the foot proper do not seem to be powerful enough, yet they respond fairly well on faradic stimulation. As a whole, however, the response to electric stimuli is not so quick as in another group of healthy muscles.

Left limb: The muscles of the thigh do not respond to faradic stimulation. There is a very slight fibrillary contraction on the anterior aspect of the quadriceps. The muscles have absolutely no potency of contraction. Muscles of the posterior region of the thigh are in the same condition. The extensors of the leg, the peroneal group of muscles, the muscles of the posterior region of the leg, show a slight response to faradic stimulation. This is similar to what would happen if the crossed pyramidal tract were divided and the muscles were under control of the direct pyramidal tract only. Occasionally application of the electrode fails to produce contraction in the same muscles which previously responded to stimulation. Again the application of electrodes may produce three or four successive reflex-like contractions. In one instance the leg entered into a spasmodic contraction after the application of the electrode, and the spasm continued even after the removal of the electrode. Once the application of a strong current elevated the leg above the plane of the table, a movement which patient had not been able to make for the past six years.

Diagnosis. Traumatic zonal paralysis of extreme severity, with possible destruction of the left half of the cord, but more likely, one of extreme inflammatory deposit in the left half and a lesion in the right.

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